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PROCEEDINGS OF JOINT MEETING OF FEDERAL AND STATE GOVERNMENTS ON MISSISSIPPI RIVER TEMPERATURE STANDARDS (2ND SESSION) HELD AT ST. LOUIS, MISSOURI ON MARCH 3, 1971

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D. C.

MARCH 1971

PB 259 867

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~~A. T. WICKS~~

SECOND SESSION
OF
JOINT MEETING OF
FEDERAL AND STATE GOVERNMENTS
ON
MISSISSIPPI RIVER TEMPERATURE STANDARDS

held in St. Louis, Missouri
March 3, 1971

TRANSCRIPT OF PROCEEDINGS

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OF
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St. Louis, Missouri

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River temperature data, low flow data, and recommendations are given in this report. ←

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PROCEEDINGS

INTRODUCTIONS
OF
PARTICIPANTS

MR. STEIN: I think we had better get started.

If we are going to keep a record of this, you are going to have to identify yourselves by your last name every time you speak. Now, we have a roster and we can sort that out for the record, but we are going to have to ask you to do it. And I see some new faces here. I think it might be best if we just went around the table and you introduced yourselves for the purpose of the record and so everyone will know who we are.

MR. RAINWATER: I am Frank Rainwater with the Environmental Protection Agency.

MR. POWERS: I am Tom Powers with the Environmental Protection Agency, Cincinnati.

DR. MOUNT: Don Mount, Environmental Protection Agency at Duluth.

MR. BRUNGS: Bill Brungs, EPA, Cincinnati.

MR. SMITH: Jack Smith, Missouri Water Pollution Board.

Introductions

MR. ODENDAHL: Jim Odendahl, Water Pollution Board.

MISS KEILHOLZ: Peggy Keilholz, Missouri Water Pollution Board.

MR. WHITLEY: James Whitley, Missouri Department of Conservation.

DR. MORRIS: Bob Morris, Iowa Water Pollution Control Association.

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MR. KEE: David Kee, Illinois Pollution Control Board.

MR. MARTIN: Harold Martin, Tennessee Stream Pollution Control Board.

MR. MULLICAN: Harold Mullican, Tennessee Stream Pollution Control Board.

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MR. BARBER: Yates Barber, Bureau of Sport Fisheries & Wildlife, Washington.

MR. DICKSTEIN: Irwin L. Dickstein, EPA, Cincinnati.

DR. TARZWELL: C. M. Tarzwell, EPA, Rhode Island.

MR. STEIN: I am Murray Stein, EPA, Washington.

We have at least, as you can see, half as many regions as we have States. Not all the States are here. That is why you think there are so many people, I think, from EPA.

And I think this is a real indication of why we are here. We have five of the EPA regions and ten of the States involved.

We are trying to come up with some feasible temperature standards that all the Mississippi River States can sign off on and that the Federal Government can endorse so we can move ahead with the program in an equitable manner. We have an agenda which has been passed out and I am going to allow Dickstein to make a resume of the meeting, but I have just several comments on the agenda.

One, I would like to certainly welcome you all here, because I think it is only by an effort of this kind that we are going to be able to really approach or solve the problem in dealing with the temperature of our inland waters, and I suspect what we do for the Mississippi drainage area is going to affect all the inland waters of the country.

Just a brief word on the agenda. Knowing downtown hotels, I suspect that that hour for lunch is unrealistic. I know with the convention they have in here you are not going to get served and we are just kidding ourselves. I would rather take a little longer and start on time than have everyone straggle in, because that is the way meetings go to pot. So perhaps we should think in terms of an hour and a half for lunch would be more realistic than that. We are going to try to stay here, at least some of the Federal people, including myself as long as we have to, until the last dog is hanged, so we can solve these questions.

At the last meeting, as far as I can see, we zeroed in on several of the real vexing problems. The obvious problems are that with the Mississippi falling as a boundary between two States, when they abut, just face each other maybe for 50 or 100 or more, maybe 200 miles, you pretty well have to have uniform temperature criteria on both sides of the river if you are going to enforce them.

Secondly, I think it is unrealistic to deal with maximum temperatures, at least this was the feeling that prevailed, all the way from Minnesota down to Louisiana. The character of the river and the natural temperature of the waters and the climate itself changes and, of course, I think we have to find that the temperature requirements in the Mississippi River and its tributaries, at least at the point of confluence, come into some kind of balance. In addition to that, we have all the 10 States operating with that, and, of course, we have had a large discussion on how you handle the concept of a mixing zone.

Part of the discussion or at least the area of agreement we sort of had last time was that the river possibly for purposes of setting up temperature standards should be divided into various zones which would be agreed upon by the States and the Federal Government and in an attempt to simplify these zones I think we have broken them down to a proposed five zones.

And then we came up with a pretty substantial agreement from all the States represented that the temperature rise allowed would be a maximum of five degrees. In addition to that, we discussed the notion that in all these places there would have to be a maximum temperature during particular months of the year and the temperature permitted would be the lesser, whether it as the five degrees or the maximum. For example, if the natural waters were 80 degrees and the maximum that you decided on is 82, during that period of time you can only allow the temperature by artificial means to go up 2 degrees, you don't have the full 5.

In order to get these maximum temperatures, I think we again agreed that the area of competence in this and the people who could give us the best advice on this are the aquatic biologists. We urged all the States to go back and consult with their biologists and possibly bring them to this meeting if they have any questions. In addition to that we have our temperature committee, which is composed of one engineer, Mr. Frank Rainwater on my left, who is serving for the secretary of this, but the rest of the group that the Federal people have are aquatic biologists and as far as I am concerned distinguished aquatic biologists and the experts I rely on.

Going from my left we have Dr. Donald Mount, who is the head of our Duluth Laboratory, Dr. Clarence Tarzwell, who is the head of our laboratory in Kingston, Rhode Island, and Mr. Yates Barber, who is our close colleague from the Fish & Wildlife Service in the Department of the Interior. And I think these people will be able to enter into discussion with you on the problems of questions you have raised about the kind of temperatures we need in order to protect the biota of the Mississippi River.

If there are no objections to this agenda, we will ask Mr. Dickstein to give us a resume of the last meeting.

Mr. Dickstein.

IRWIN L. DICKSTEIN
EPA - WATER QUALITY OFFICE
CINCINNATI, OHIO

MR. DICKSTEIN: Thank you, Mr. Stein.

As you know, on January 20 and 21 we met here in St. Louis to review the States water quality standards on the Mississippi River. The States indicated that there are inconsistencies with the water quality standards between the various boundary States and the objective of that meeting was to evaluate the data and attempt to arrive at some uniform standards for the Mississippi River.

It was obvious that due to geographical locations that no one temperature would persist or protect the existing biota in the Mississippi River. Because of this, we decided to go to zoning and zones were recommended. At that time EPA recommended eight zones. After much discussion, those present at the meeting decided that five zones would be much better than eight zones, easier to handle. So we decided on the following five zones.

You have copies of the maps in your handouts and also a description of the zones. However, we will show them on the screen so you can have once again a visual concept of what the zones are.

Zone I is from the headwaters up in Minnesota to the Rum River.

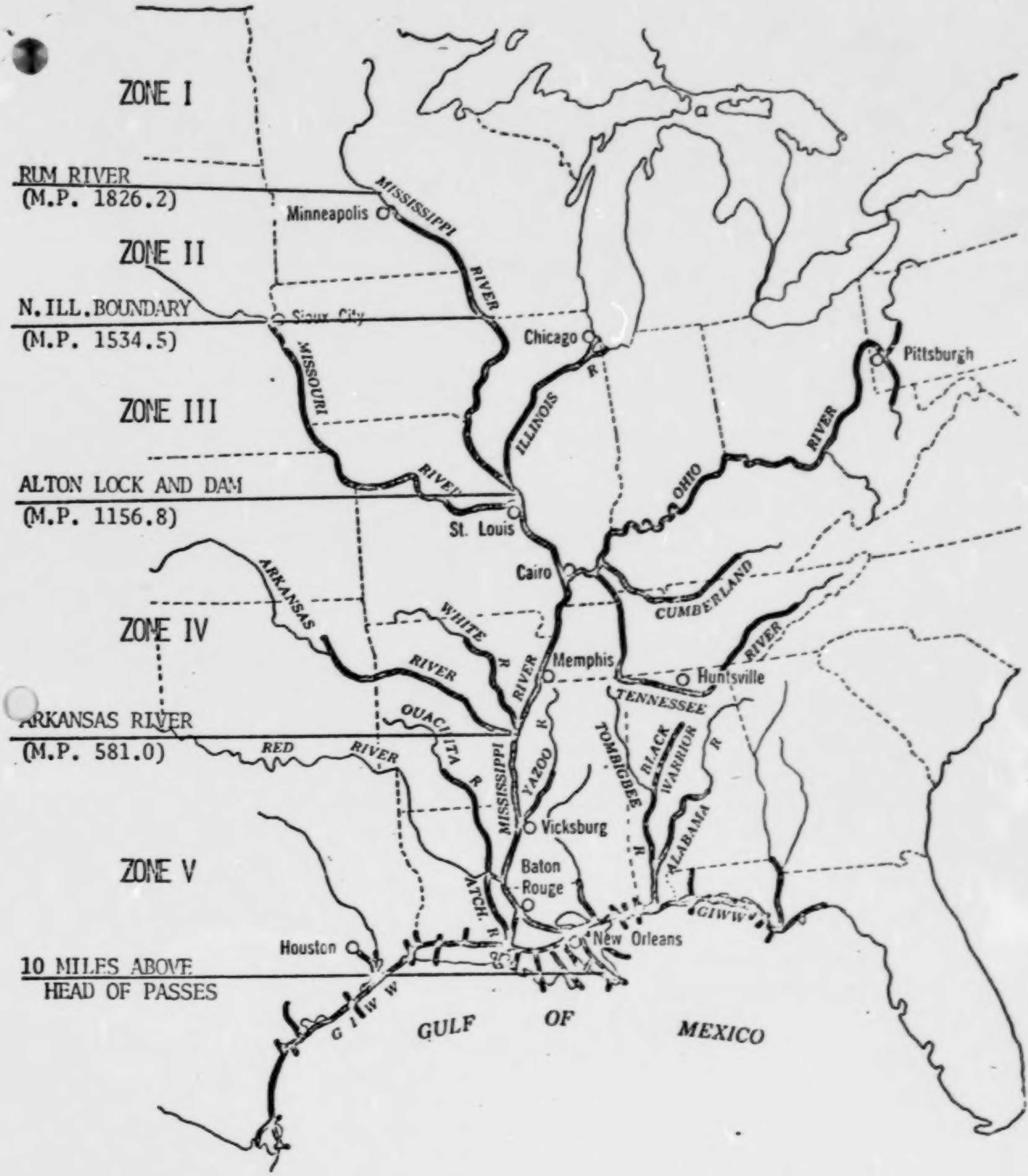
Zone II is from the Rum River to the northern Illinois boundary.

Zone III is the northern Illinois border to the Alton Lock and Dam.

Zone IV, Alton Lock and Dam to the Arkansas River.

And Zone V is the Arkansas River to the tidal waters of Gulf of Mexico or the Head of Passes. Now, this was agreed upon at the last meeting.

WATER QUALITY STANDARDS FOR THE MISSISSIPPI RIVER


ZONE I
RUM RIVER
(M.P. 1826.2)
ZONE II
N.ILL.BOUNDARY
(M.P. 1534.5)
ZONE III
ALTON LOCK AND DAM
(M.P. 1156.8)
ZONE IV
ARKANSAS RIVER
(M.P. 581.0)
ZONE V
10 MILES ABOVE
HEAD OF PASSES
Minneapolis
MISSISSIPPI RIVER
Sioux City
MISSOURI RIVER
Chicago
ILLINOIS R
St. Louis
Cairo
Pittsburgh
OHIO RIVER
CUMBERLAND RIVER
ARKANSAS RIVER
WHITE R
Memphis
MISSISSIPPI RIVER
Huntsville
TENNESSEE RIVER
OUACHITA R
RED RIVER
YAZOO R
TOMBIGBEE R
BLACK WARRIOR R
ALABAMA R
Vicksburg
Baton Rouge
ATCH. R
New Orleans
Houston
GIWW
GULF OF MEXICO

MISSISSIPPI RIVER TEMPERATURE ZONES

Zone	Description	Mile Point*
I	Headwaters to Rum River	1826.2
II	Rum River to Northern Illinois Boundary	1534.6
III	Northern Illinois Border to Alton Lock and Dam	1156.8
IV	Alton Lock and Dam to Arkansas River	581.0
V	Arkansas River to 10.0 miles above Head of Passes	10.0

* Miles above Head of Passes at Mile Point (0.0).

LENGTH OF THE MISSISSIPPI RIVER

The Mississippi is the only river in North America ranking in the 10 largest of the world's rivers. Of these 10, the Mississippi is third in length, third in drainage area, and fifth in volume.

For comparative purposes, the length of rivers is calculated through the longest tributary. Therefore, the total length of the Mississippi is considered as 3,484 miles, since its longest tributary, the Missouri, is 2,315 miles long measured from its headwaters at Three Forks, Mont., where the Jefferson, Madison, and Gallatin Rivers unite.

The following tabulation shows the length of the Mississippi from its headwaters in Minnesota:

Lake Itasca (headwaters) to Minneapolis, Minn.	513 mi.
Minneapolis, Minn., to Cairo, Ill. (Ohio River)	853 mi.
Cairo, Ill., to New Orleans, La. (Canal Street)	859 mi.
New Orleans, La., to Head of Passes, La.	95 mi
Head of Passes (via Southwest Pass) to Gulf of Mexico, La.	20 mi.
Length	2,340 mi.

I. L. Dickstein

It was also agreed upon at the last meeting that a 5-degree rise above natural would be the maximum allowable rise.

There was some question at the last meeting as to what species were prevalent in the various zones and what maximum monthly temperature was necessary to protect these particular species. It was decided at that time that the biologists representing both EPA and the States be brought together to resolve this problem. That is the prime objective of the meeting today.

It was also apparent at the last meeting that all temperature data available was not reviewed, essentially the Federal data, which was EPA and USGS data. At that time we decided it was important to also see what data the States had available and incorporate them into our decision-making apparatus. The data was obtained from the States and the booklets that you have in front of you represent all Federal and State data that has been made available to us.

Mr. Powers will now summarize the format of this data so you can essentially understand what these various tables mean.

Tom.

THOMAS J. POWERS, JR.
EPA - OFFICE OF REGULATORY PROGRAMS
WATER QUALITY STANDARDS BRANCH
CINCINNATI, OHIO

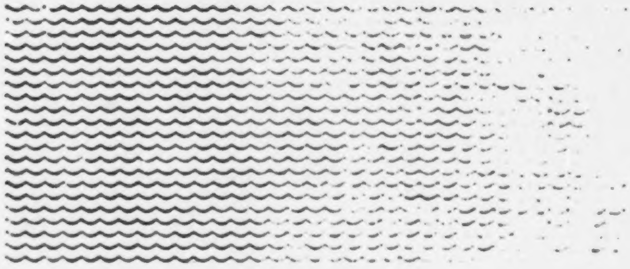
MR. POWERS: Basically, we decided to give you a broad spectrum of what type of data and where the location of the data actually was on the river, so we used the Corps of Engineer official mileage maps to determine as closely as possible the stations on the river. Your booklet is assembled starting in Minnesota and going all the way down through Louisiana, based on these mileage points. And, of course, in the upper portions of the Mississippi River we had to add the Ohio River mileage to the Corps of Engineers mileage.

So I wanted to show you, we have got a lot of plots that came out of the book or some other data we have and I want to show you some of the data that is available.

(The data referred to follows:)

MISSISSIPPI RIVER

Water Quality Standards



TEMPERATURE DATA SUMMARY

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1885.5 (Est.)

Station Description: MISSISSIPPI RIVER AT SAUK RAPIDS, MINN. Sauk Rapids, Bridge on SH 152. Minnesota Department of Health

Data from 1953 to 1963

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	4	33	32		
February	2	33	32		
March	4	38	32		
April	8	54	39		
May	6	67	34		
June	10	78	32		
July	4	79	70		
August	6	79	70		
September	4	73	58		
October	6	58	43		
November	4	39	32		
December	4	33	32		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1837.5

Station Description: MISSISSIPPI RIVER AT ELK RIVER (MINN.) Bridge on State Highway 101, Minnesota Department of Health

Data from 1957 to 1965

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	4	32	32		
February	6	34	32		
March	2	34	34		
April	4	51	40		
May	8	70	52		
June	6	72	64		
July	7	82	70		
August	4	82	70		
September	5	68	54		
October	6	60	40		
November	4	45	40		
December	6	33	32		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1826.5

Station Description: MISSISSIPPI RIVER AT ANOKA, MINN. Bridge on US Highway 169. Minnesota Department of Health

Data from 1953 to 1963

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	7	32	32		
February	7	33	32		
March	4	46	32		
April	7	53	40		
May	9	69	52		
June	11	73	64		
July	10	84	70		
August	6	82	70		
September	7	69	56		
October	8	60	40		
November	6	45	32		
December	8	33	32		

TJP

Mile Point 1826.2 - Rum River

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1818.6

Station Description: MISSISSIPPI RIVER AT ANOKA, MINNESOTA USGS Station # 05288500 Lat. 450736 - Long. 04931748 On Route 169 west; Right bank 0.5 mile downstream from Coon Creek, 1.5 mile downstream of Northern States Power Co., 6.5 miles downstream from Anoka, at mile 864.8 upstream Ohio River.

Data from 1960 WYR to 1963 WYR

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	93	34	32.5		
February	82	35	32.5		
March	92	38.5	32.5		
April	90	53	34		
May	93	67	45.8		
June	90	75	54		
July	93	85	55		
August	120	82	54.5		
September	120	81	44.5		
October	93	63	39		
November	90	47	32.5		
December	93	46	32.5		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1810.7

Station Description: MISSISSIPPI RIVER AT MINNEAPOLIS, MINNESOTA. Northern States Power Company's Riverside Power Plant. Minneapoli's Auto Monitor, STORET

Data from June 7, 1967 to June 31, 1969

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous	38.0	32.0		
February	"	39.0	32.0		
March	"	53.2	32.0		
April	"	58.5	33.9		
May	"	75.5	51.0		
June	"	79.0	59.0		
July	"	84.5	63.5		
August	"	84.3	66.0		
September	"	72.6	53.5		
October	"	65.0	37.0		
November	"	50.6	32.0		
December	"	37.5	32.0		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1793.1

Station Description: MISSISSIPPI RIVER AT ST. PAUL, MINNESOTA. USGS Station # 05331000 Lat. 445640 - Long. 0930520 Temperature recorder at gaging station on left bank in St. Paul, Ramsey Co. 300 ft. upstream from Robert St. bridge, 6 miles downstream from Minnesota River, at mile 839.3 upstream from the Ohio River.

Data from ____ to ____

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1780.3

Station Description: MISSISSIPPI RIVER AT ST. PAUL PARK, MINNESOTA ULSHIE ST. PAUL PARK AUTO MONITOR ; STORET : J.L. Shiely Company, Larson Plant.

Data from June 7, 1967 to January 2, 1971

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous	39.5	32.0		
February	"	40.0	32.0		
March	"	51.8	32.0		
April	"	59.0	32.3		
May	"	75.0	51.0		
June	"	82.8	61.5		
July	"	84.5	64.5		
August	"	84.6	70.0		
September	"	80.7	59.0		
October	"	70.0	44.0		
November	"	50.0	32.0		
December	"	41.9	32.0		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1750.7

Station Description: MISSISSIPPI RIVER AT RED WING MINNESOTA, Prairie Island Nuclear Generating Plant, Circulating Water System, June 15, 1969. Northern States Power Company, Engineering Dept., Minneapolis Minn., Fig. 17

Data from 1949 to 1968

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	600(Est)	33			
February	"	35			
March	"	48			
April	"	65			
May	"	72			
June	"	78			
July	"	83			
August	"	85			
September	"	79			
October	"	70			
November	"	56			
December	"	44			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1750.7

Station Description: MISSISSIPPI RIVER AT RED WING MINNESOTA - RED WING DAM FWPCA AUTO MONITOR ; STORET Red Wing Lock and Dam No.3

Data from Sept 12, 1969 to June 13, 1970 ; Jan 2, 1971

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous	35.0	32.5		
February	"	35.0	32.0		
March	"	40.0	33.6		
April	"	63.0	37.0		
May	"	70.5	53.3		
June	"	80.4	63.1		
July	"	84.0	75.7		
August	"	83.7	72.3		
September	"	77.2	59.2		
October	"	66.0	44.6		
November	"	49.5	32.0		
December	"	35.2	32.6		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1750.7 STORET 260027

Station Description: MISSISSIPPI RIVER BELOW ST. PAUL. SAMPLED BY US ARMY CORPS OF ENGINEERS AND MINNEAPOLIS - ST. PAUL SANITARY DISTRICT. (RED WING, MINNESOTA)

Data from Oct 30, 1957 to present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	40	34.3	32.0	32.5	0.47
February	43	35.2	32.0	32.8	0.84
March	48	41.0	32.0	34.8	2.21
April	34	57.2	33.8	45.0	5.95
May	40	67.1	43.7	58.5	5.5
June	52	78.6	61.9	69.2	3.67
July	48	82.9	64.9	75.3	3.76
August	48	81.0	65.3	74.2	3.81
September	42	79.2	52.0	65.6	5.44
October	38	63.5	45.3	54.6	5.52
November	44	52.7	32.4	40.7	5.00
December	39	43.9	32.0	33.5	2.05

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1716.6 (?)

Station Description: MISSISSIPPI RIVER AT ALMA, WISCONSIN Alma, Wisconsin Power Station of Dairyland Power Cooperative.

Data from January 1958 to Dec 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	390 (Est.)	40	33		
February	"	41	34		
March	"	50	32		
April	"	58	32		
May	"	71	46		
June	"	78	60		
July	"	84	64		
August	"	83	66		
September	"	78	54		
October	"	68	41		
November	"	55	33		
December	"	46	34		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1613.8

Station Description: MISSISSIPPI RIVER AT LANSING IOWA. Inlet water temperature Lansing Plant - Interstate Power Company. River Milepost: 660 - (Car graph of monthly max and minimum temperatures taken at the intake to condenser.)

Data from Jan. 1956 to Dec. 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous	41	32		
February	"	40	32		
March	"	54	32		
April	"	66	32		
May	"	76	45		
June	"	85	61		
July	"	87	66		
August	"	84	66		
September	"	82	53		
October	"	67	42		
November	"	57	32		
December	"	48	32		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1560.0

Station Description: MISSISSIPPI RIVER AT CASSVILLE, WISCONSIN. Stoneman Station of Dairyland Power Cooperative

Data from March 1951 to December 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	600 (Est)	38	32		
February	"	37	32		
March	"	54	33		
April	"	65	33		
May	"	77	45		
June	"	85	63		
July	"	88	66		
August	"	88	68		
September	"	84	53		
October	"	76	41		
November	"	59	32		
December	"	43	32		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1536.9

Station Description: MISSISSIPPI RIVER AT DUBUQUE, IOWA
DNR 1962-1968 Monthly Sample -
WISCONSIN Data Lock and Dam No. 11

Data from 1962 to 1968

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	7	37			
February	7	34			
March	7	48			
April	7	55			
May	7	78			
June	7	84			
July	7	85			
August	7	85			
September	7	78			
October	7	61			
November	7	47			
December	7	35			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1536.80 STORET 180026

Station Description: MISSISSIPPI RIVER AT DUBUQUE, IOWA. ALL SAMPLES TAKEN AT LOCK AND DAM NO. 11 BY DUBUQUE WATER DEPARTMENT

Data from Dec. 12, 1957 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	27	36.0	32.2	33.0	0.846
February	30	36.0	32.4	33.5	1.10
March	35	47.8	32.7	36.3	3.52
April	26	59.9	36.3	46.9	6.58
May	30	74.3	41.0	63.1	7.03
June	40	80.6	64.4	71.5	3.45
July	35	82.4	70.1	76.2	3.54
August	30	86	69.9	79.1	3.42
September	31	78.4	61.0	70.1	6.15
October	27	73.0	47.5	58.0	6.67
November	34	59.0	32.9	43.8	6.89
December	30	41	32.2	34.2	2.44

TJP

Mile Point 1534.6 - Northern Illinois-Wisconsin Boundary

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1533.8

Station Description: MISSISSIPPI RIVER AT DUBUQUE, IOWA Inlet temperature Dubuque Plant (River Milepost: 580) Interstate Power Company Monthly maximum and minimum temperatures taken at intake to condenser.

Data from January 1956 to December 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	continuous	36	32		
February	"	36	33		
March	"	53	33		
April	"	68	33		
May	"	82	48		
June	"	87	60		
July	"	87	67		
August	"	88	69		
September	"	84	56		
October	"	69	44		
November	"	60	32		
December	"	40	32		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1467.8

Station Description: MISSISSIPPI RIVER AT CLINTON IOWA - INLET WATER TO CONDENSER AT BEAVER CHANNEL PLANT (M.L. KAPP STATION) INTERSTATE POWER COMPANY. (RIVER MILEPOST : 514) Information Presented at the Iowa Standard Setting Conference Davenport, Iowa April 8, 1969.

Data from January 1955 to March 1969

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous	42	33		
February	"	43	33		
March	"	57	33		
April	"	69	34		
May	"	77	48		
June	"	85	62		
July	"	90✓ 87	67		
August	"	89✓ 87	68		
September	"	85✓ 85	54		
October	"	75✓ 71	46		
November	"	67✓ 60	33		
December	"	44			

✓ - Data in question : 1955, July through November

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1444.1

Station Description: MISSISSIPPI RIVER AT BETTENDORF, IOWA IOWA-ILLINOIS GAS AND ELECTRIC COMPANY - Riverside Plant - Water intake approximately 10' below the surface just below the mouth of the Crow Creek. (Temperatures indicated were highest readings observed in the 24 hour period of the intake water log readings).

Data from 1957 to 1967

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous				
February	"				
March	"				
April	"				
May	"				
June	"	85			
July	"	88			
August	"	86			
September	"	86			
October	"				
November	"				
December	"				

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1441.8 (?)

Station Description: MISSISSIPPI RIVER AT MOLINE, ILLINOIS Moline Water Plant (Effluent of low-lift pumps.)

Data from 1951 to 1961

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	330 (Est.)	40	33	33	
February	"	39	33	33	
March	"	47	33	36	
April	"	64	34	48	
May	"	73	47	62	
June	"	83	61	73	
July	"	87	71	79	
August	"	87	71	78	
September	"	82	56	70	
October	"	69	46	57	
November	"	59	33	42	
December	"	42	33	34	

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1438.8

Station Description: MISSISSIPPI RIVER AT MOLINE, ILLINOIS IOWA-ILLINOIS GAS AND ELECTRIC COMPANY Moline Plant located on the Illinois shore upstream tip of Sylvan Island and water is withdrawn from a Water Power Dam.

Data from 1957 to 1967

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Continuous				
February	"				
March	"				
April	"				
May	"				
June	"	84			
July	"	87			
August	"	87			
September	"	85			
October	"				
November	"				
December	"				

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1358.00 STORET 180025

Station Description: MISSISSIPPI RIVER AT BURLINGTON, IOWA. SAMPLED AND FIELD ANALYSIS BY BURLINGTON WATER DEPARTMENT. OTHER COOPERATING AGENCIES - IOWA STATE

Data from Oct 28, 1957 **to** Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	3	44.6	34.7	38.3	5.47
February	4	33.8	33.8	33.8	0.00
March	5	45.5	33.8	39.1	4.79
April	4	58.1	51.8	54.7	2.69
May	4	68.0	56.3	63.0	5.01
June	5	74.3	69.8	71.6	2.11
July	4	76.1	73.4	74.4	1.17
August	4	81.5	78.8	80.2	1.16
September	4	75.2	69.8	71.8	2.37
October	4	64.4	61.7	62.5	1.34
November	6	59.4	46.4	54.1	5.19
December	10	56.8	33.8	41.4	8.93

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1318.4 (?)

Station Description: Illinois - Hamilton Water Plant

MISSISSIPPI RIVER AT HAMILTON, ILLINOIS

Data from 1958 to 1961

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	120 (est)	42	36	39	
February	"	44	36	39	
March	"	54	34	42	
April	"	66	44	54	
May	"	76	54	66	
June	"	84	68	74	
July	"	86	74	79	
August	"	86	76	81	
September	"	84	64	74	
October	"	68	50	61	
November	"	60	36	48	
December	"	50	36	41	

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1297.0

Station Description: MISSISSIPPI RIVER AT CANTON, MISSOURI USGS Station # 05495150

Data from May 1969 to Sept 1969

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January					
February					
March					
April					
May	Unknown	71	58		
June	"	75.2	63		
July	"	82.4	71.6		
August	"	82.4	75.2		
September	"	78.8	62.6		
October					
November					
December					

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1296.8 (?)

Station Description: MISSISSIPPI RIVER AT CANTON, MISSOURI
City of Canton 124 North Fifth Street
Water plant intake.

Data from 1968 to 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	40(Est)	34			
February	"	42			
March	"	48			
April	"	56			
May	"	73			
June	"	77			
July	"	84			
August	"	86			
September	"	82			
October	"	70			
November	"	55			
December	"	48			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1281.8 (?)

Station Description: Illinois - Quincy Raw Water Pump Discharge

Data from 1951 to 1961

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	330 (est)	39	32	35	
February	"	45	32	35	
March	"	48	34	40	
April	"	64	37	51	
May	"	73	52	63	
June	"	84	61	74	
July	"	84	72	79	
August	"	86	72	79	
September	"	84	61	72	
October	"	70	48	60	
November	"	61	34	46	
December	"	46	32	37	

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1264.3(?)

Station Description: MISSISSIPPI RIVER AT HANNIBAL, MISSOURI Hannibal Power Plant

Data from 1961 to 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	300(Est.)	34			
February	"	37			
March	"	49			
April	"	56			
May	"	72			
June	"	78			
July	"	82			
August	"	87			
September	"	74			
October	"	67			
November	"	55			
December	"	39			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1234.8

Station Description: MISSISSIPPI RIVER AT LOUISIANA, MISSOURI Hercules, Incorporated (chemical plant)

Data from Oct 1957 to Dec 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	390 (Est.)	40			
February	"	38			
March	"	48			
April	"	64			
May	"	76			
June	"	82			
July	"	87			
August	"	86			
September	"	85			
October	"	71			
November	"	66			
December	"	47			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1156.8(?)

Station Description: Illinois - Alton Water Plant
Alton Dam No. 26, Raw Water Intake

Data from 1959 to 1962

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	90(est)	39	33	34	
February	"	39	33	35	
March	"	50	33	41	
April	"	66	45	53	
May	"	76	56	65	
June	"	84	69	77	
July	"	85	75	80	
August	"	87	78	83	
September	"	86	65	77	
October	"	71	53	63	
November	"	57	38	48	
December	"	44	33	38	

TJP

Mile Point 1156.8 - Alton, Illinois
Lock and Dam No. 26

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1149.4 STORET 280025

Station Description: MISSOURI RIVER AT ST. LOUIS MISSOURI. SAMPLED BY ST. LOUIS COUNTY WATER COMPANY AND ST. LOUIS WATER DEPARTMENT. OTHER COOPERATING AGENCIES ARE MISSOURI DEPARTMENT OF PUBLIC HEALTH AND MISSOURI WATER POLLUTION BOARD.

Data from October 1957 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	53	44.1	32.0	35.8	3.09
February	49	46.9	32.0	37.0	3.48
March	52	55.0	33.1	42.5	5.39
April	51	64.9	43.0	54.9	6.28
May	52	78.1	57.0	65.7	5.88
June	51	82.0	63.0	74.0	3.84
July	49	84.9	73.0	79.8	3.00
August	46	86.0	73.9	79.7	2.72
September	46	82.9	63.0	72.9	4.61
October	53	72.0	45.0	61.6	4.51
November	54	62.1	36.0	49.7	5.69
December	52	52.0	32.0	39.2	4.37

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1143.8 STORET 160024

Station Description: MISSISSIPPI RIVER AT EAST ST. LOUIS, ILLINOIS. SAMPLED AND FIELD ANALYSIS BY EAST ST. LOUIS WATER COMPANY. OTHER COOPERATING AGENCY IS THE ILLINOIS STATE DEPT. OF PUBLIC HEALTH.

Data from DEC. 24, 1957 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	47	37.9	32.9	34.4	1.47
February	42	37.9	32.4	34.4	1.67
March	52	49.1	32.4	39.9	4.40
April	49	62.0	39.6	52.8	5.98
May	45	76.1	55.8	64.4	5.25
June	40	81.9	66.9	74.6	3.47
July	42	86.7	74.3	80.2	2.95
August	46	86.7	75.0	80.5	3.22
September	40	83.1	65.8	73.4	6.15
October	46	76.1	51.0	63.7	4.77
November	42	58.6	37.2	49.7	5.28
December	30	44.8	33.8	39.0	3.41

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1133.0

Station Description: MISSISSIPPI RIVER AT ST. LOUIS, MISSOURI. USGS Station # 07010000 Lat. 383703 - Long. 0901058 at Poplar Street Highway Bridge 0.9 mile downstream from gaging station, 15.9 miles downstream from Missouri River, 18.3 miles upstream from Mermec River, 179.1 miles upstream from Ohio River

Data from Oct 1951 to Sept 1969

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	160	44			
February	169	48			
March	202	53			
April	202	67			
May	197	76			
June	205	84			
July	206	88			
August	201	89			
September	190	85			
October	214	75			
November	191	60			
December	113	51			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1063.8 (?)

Station Description: Illinois – Chester Influent to Water Treatment Plant

Data from 1951 to 1961

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	330 est.	50	34	37	
February	"	54	34	41	
March	"	68	34	46	
April	"	72	45	57	
May	"	86	43	68	
June	"	86	68	77	
July	"	91	73	82	
August	"	95	75	83	
September	"	86	66	76	
October	"	75	54	65	
November	"	63	36	50	
December	"	52	34	40	

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1044.3

Station Description: MISSISSIPPI RIVER AT CHAIN OF ROCKS, ST. LOUIS, MISSOURI St. Louis City Water Company These data are collected on the west bank of the River and are mainly Missouri River water before mixing with upstream Mississippi River Water.

Data from April 1956 to March 1967

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	330 (Est)	45			
February	"	51			
March	"	56			
April	"	68			
May	"	79			
June	"	85			
July	"	88			
August	"	87			
September	"	82			
October	"	71			
November	"	62			
December	"	51			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1008.1

Station Description: MISSISSIPPI RIVER AT CAPE GIRARDEAU, MISSOURI USGS Station #07020850 Lat. 371949 - 0892939 At raw water intake of Missouri Utilities Company water treatment plant 54.3 miles above Ohio River.

Data from ____ to ____

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1007.0 STORET 280023

Station Description: MISSISSIPPI RIVER AT CAPE GIRARDEAU, MISSOURI. SAMPLED AND FIELD ANALYSIS BY MISSOURI UTILITIES COMPANY. OTHER COOPERATING AGENCIES INCLUDE MISSOURI DEPARTMENT OF PUBLIC HEALTH AND MISSOURI WATER POLLUTION BOARD.

Data from Jan 6 1958 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	53	42.8	32.0	37.1	2.49
February	48	42.8	32.0	39.0	—
March	54	60.8	35,6	43.8	4.62
April	50	65,3	44.6	55.0	5.56
May	53	77.0	35,1	66.1	6,58
June	47	88,4	68,0	75.5	3.22
July	49	86.0	77.0	81.0	2,71
August	49	86.9	77.0	81.6	2.48
September	47	83.3	68.0	75.1	3.71
October	50	71.6	53.6	63.9	4.30
November	46	60.8	39.2	51.5	4.59
December	48	48.2	35,6	41.4	3.38

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 1007.0(?)

Station Description: MISSISSIPPI RIVER AT CAPE GIRARDEAU, MISSOURI Missouri Utilities Company - Water Plant

Data from Jan. 1963 to Dec 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	240(Est.)	42.8			
February	"	42.0			
March	"	58.0			
April	"	66.0			
May	"	78.0			
June	"	83.0			
July	"	88.0			
August	"	89.0			
September	"	84.2			
October	"	75.0			
November	"	64.0			
December	"	46.4			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 997.5

Station Description: MISSISSIPPI RIVER AT THEBES, ILLINOIS USGS Station # 7-0220 Thebes Railroad Bridge 43.7 miles above Ohio River.

Data from 1952 to 1969

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	21	43	32		
February	21	41	33		
March	32	53	33		
April	18	64	47		
May	32	77	58		
June	32	83	63		
July	31	86	59		
August	28	91	75		
September	30	83	67		
October	30	77	49		
November	25	60	44		
December	21	48	33		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 953.8 STORET 160035

Station Description: OHIO RIVER AT CAIRO, ILLINOIS SAMPLING AND FIELD ANALYSIS BY CAIRO WATER COMPANY.

Data from April 7, 1958 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	46	47.7	32.4	37.8	3.96
February	43	44.6	32.4	38.1	3.52
March	47	54.5	32.9	43.7	5.40
April	45	66.2	46.8	55.3	4.76
May	49	79.5	58.3	67.1	4.85
June	45	83.3	36.9	76.3	7.15
July	46	86.4	76.1	82.0	2.30
August	45	86.9	69.8	81.4	3.43
September	50	86.0	71.6	78.0	3.46
October	44	77.0	58.1	67.1	5.17
November	43	61.7	33.8	54.7	4.72
December	47	50.7	32.5	43.9	4.31

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 826.7

Station Description: MISSISSIPPI RIVER AT HUFFMAN LANDING, ARKANSAS St. Francis Four is located on the Mississippi River in Section 29, T16N, R13E, in Mississippi County, about 0.5 miles east of the east end of Highway 150, at the loading platform of the River Grain Company. Arkansas Pollution Control Commission.

Data from 1968 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	4	39	34		
February	4	39	37		
March	4	50	43		
April	5	66	50		
May	6	79	66		
June	4	84	75		
July	3	86	82		
August	5	86	81		
September	5	81	73		
October	7	75	57		
November	3	50	45		
December	5	45	37		

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 729.0 STORET 040022

Station Description: MISSISSIPPI RIVER AT WEST MEMPHIS SAMPLED AND FIELD ANALYSIS BY MEMPHIS TENN. LIGHT, GAS, AND WATER DIVISION. OTHER COOPERATING AGENCIES INCLUDE ARKANSAS STATE BOARD OF HEALTH AND TENNESSEE DEPT. OF PUBLIC HEALTH.

Data from January 1958 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	45	45.1	32	38.6	3.12
February	42	46.0	33.4	40.2	2.57
March	38	51.8	35.6	45.1	4.25
April	39	65.5	48.0	57.0	—
May	50	78.6	59.0	67.3	4.83
June	58	82.6	66.9	76.5	2.97
July	53	87.8	75.7	81.9	2.58
August	57	87.6	76.1	82.1	2.51
September	55	87.8	69.8	77.0	4.21
October	56	75.9	42.6	65.3	5.98
November	52	68.0	41.2	53.7	4.99
December	48	50.2	34.0	43.7	3.67

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 661.3

Station Description: MISSISSIPPI RIVER AT HELENA, ARKANSAS St. Francis One is located on the Mississippi River in Section 29, T2S, R5E, in Phillips County, about one mile south of Helena, at the boat ramp of the Corps of Engineers material storage area just past the Arkansas Grain Company over the levee. Arkansas Pollution Control Commission.

Data from 1968 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	5	43	37		
February	5	46	39		
March	4	52	43		
April	5	64	55		
May	5	75	64		
June	7	82	72		
July	4	86	82		
August	4	86	82		
September	5	86	77		
October	5	73	63		
November	4	59	52		
December	5	50	46		

TJP

Mile Point 581.0 - Arkansas River

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 438.7 STORET 21 0054

Station Description: MISSISSIPPI RIVER AT DELTA LOUISIANA ALL SAMPLES TAKEN FROM AN M-2C FIELD UNIT ON RIVER BANK APPROXIMATELY 1 MILE ABOVE VICKSBURG, MISSISSIPPI. SAMPLED BY WARREN COUNTY HEALTH DEPARTMENT. FIELD ANALYSIS BY MISSISSIPPI STATE BOARD OF HEALTH AND FWPCA

Data from ____________ to ____________

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	5	44.6	39.92	41.9	1.74
February	11	48.0	37.9	42.2	3.34
March	10	55.9	42.8	48.7	4.54
April	8	73.0	50.0	60.5	7.15
May	10	73.9	63.0	66.6	4.01
June	9	82.4	72.0	77.3	4.08
July	10	87.8	80.0	83.7	2.50
August	10	88.0	66.0	80.9	6.14
September	8	86.0	66.9	77.6	6.07
October	14	79.5	60.1	69.5	5.47
November	12	62.1	45.3	54.3	6.21
December	8	54.0	41.4	45.3	4.25

TJP

SU[illegible] OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 436.4 STORET 270021

Station Description: MISSISSIPPI RIVER AT VICKSBURG, MISSISSIPPI. Sampled by Vicksburg Water Dept.

Data from 1957 to 1959
1961 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	48	50.0	35.6	43.2	3.46
February	39	51.8	37.4	44.5	3.33
March	46	57.2	41.0	50.1	3.79
April	46	69.8	52.7	60.4	4.66
May	46	82.4	64.4	71.0	4.45
June	45	84.2	71.6	78.3	2.91
July	47	87.8	73.4	82.7	2.76
August	48	87.8	78.8	83.3	2.18
September	44	85.6	71.6	79.0	3.60
October	46	82.6	60.8	69.1	4.34
November	42	66.2	51.8	59.7	4.25
December	50	60.8	38.8	49.7	5.39

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 266.0 (?)

Station Description: MISSISSIPPI RIVER AT ST. FRANCISVILLE, LA. State of Louisiana - Data Summary

Data 1961; 1965

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	—			
February	"	37			
March	"	50			
April	"	55			
May	"	72			
June	"	82			
July	"	90			
August	"	90			
September	"	86			
October	"	73			
November	"	66			
December	"	57			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 266.0

Station Description: MISSISSIPPI RIVER AT ST. FRANCISVILLE. USGS Station #07373423 Lat 30°45'30" Long 91°23'45" West Feliciana Parish, at ferry at State Highway 10 crossing 2 miles southwest of St. Francisville.

Data from August 1954 to Sept 1968; also 1970 W.YR. continuous monitor data.

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknow	57	33.8*		
February	"	45.5	37.4		
March	"	61.8	42.8		
April	"	67	53.6		
May	"	76	62.6		
June	"	82.4	74.3		
July	"	88*	79.8		
August	"	88*	80		
September	"	83	74		
October	"	75.2	58		
November	"	68	46.4		
December	"	57	45.5		

* Highest & Lowest Recorded Temperatures - August 1954 to Sept 1968.

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 208.7 (?)

Station Description: MISSISSIPPI RIVER AT PLAQUEMINE, LA.

Data from 1966 to 1970, 1961 and 1965

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	45			
February	"	48			
March	"	52			
April	"	72			
May	"	77			
June	"	84			
July	"	93.2			
August	"	90			
September	"	88			
October	"	77			
November	"	72			
December	"	63			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 175.3(?)

Station Description: MISSISSIPPI RIVER AT DONALDSONVILLE, LA.

Data 1961 and 1965

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	—			
February	"	37			
March	"	50			
April	"	55			
May	"	70			
June	"	84			
July	"	90			
August	"	90			
September	"	79			
October	"	75			
November	"	72			
December	"	59			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 148.0 (?)

Station Description: MISSISSIPPI RIVER AT LUTCHER, LA.

Data from 1966 to 1970 ; 1961

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	45			
February	"	50			
March	"	52			
April	"	70			
May	"	79			
June	"	84			
July	"	86			
August	"	90			
September	"	86			
October	"	79			
November	"	72			
December	"	59			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 146.0 (?)

Station Description: MISSISSIPPI RIVER AT GRAMERCY, LA.

Data [redacted] 1961 & 1965 [redacted]

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	—			
February	"	37			
March	"	50			
April	"	55			
May	"	70			
June	"	84			
July	"	90			
August	"	91			
September	"	79			
October	"	79			
November	"	72			
December	"	59			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 120.7

Station Description: MISSISSIPPI RIVER AT LULING FERRY, LOUISIANA USGS Station # 07374400 Lat. 295619 - Long. 0902149 St. Charles Parrish at Luling to Destrehan Ferry Crossing 17.0 miles west of New Orleans.

Data from 1966 to 1970 and 1961 & 1965 (State of Louisiana data - USGS 1960 WYR to 1967 W YR

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	45			
February	"	50			
March	"	55			
April	"	70			
May	"	79			
June	"	84			
July	"	90			
August	"	91			
September	"	88			
October	"	79			
November	"	72			
December	"	59			

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 103.9 STORET 210020

Station Description: MISSISSIPPI RIVER AT NEW ORLEANS, LA. ACTIVATION DATE DEC. 12, 1957. SAMPLED BY NEW ORLEANS SEWAGE AND WATER BOARD. FIELD ANALYSIS BY LOUISIANA STATE DEPT. OF HEALTH ; USGS Station # 07374508 Lat. 295703 - Long. 0900817 At Orleans-Jefferson Parrish line at Carrollton Street Municipal Water Plant.

Data from Dec. 1957 to Present

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	45	59.0	35.6	42.5	4.69
February	43	48.2	37.9	43.5	2.90
March	49	57.2	39.9	48.0	3.88
April	51	66.0	44.6	56.3	5.64
May	52	78.1	57.2	67.7	4.87
June	48	82.4	60.8	75.9	4.55
July	53	90.0	72.0	81.4	3.57
August	52	87.8	72.0	82.8	3.57
September	51	91.9	68.0	80.7	4.62
October	54	82.4	57.9	71.1	5.93
November	46	72.0	43.0	57.4	5.85
December	48	60.0	33.8	49.0	5.60

TJP

SUMMARY OF MISSISSIPPI RIVER TEMPERATURE DATA

Mile Point 75.8(?)

Station Description: MISSISSIPPI RIVER AT BELLE CHASSE, LA.

Data from 1966 to 1970

	Number Observations	Maximum Temperature, °F.	Minimum Temperature, °F.	Mean Temperature, °F.	Std. Dev.
January	Unknown	48			
February	"	48			
March	"	57			
April	"	61			
May	"	70			
June	"	77			
July	"	86			
August	"	88			
September	"	86			
October	"	77			
November	"	66			
December	"	61			

TJP

MR. POWERS: This is East St. Louis, Illinois, Mile Point 1143.8. It is a STORET station. We were able to get a computer printout, which we have over here, which listed the ascending values of the month of January and February all through the year and we did this for all the STORET data. We could have made plots for all of them if we had had time.

For January and February this shows very little variation off the 32- and 33-degree temperatures for a large portion of the time. At least 30 percent or so of the time the values are below, say, 33 degrees for both January and February at this station.

In this particular case your standard deviation doesn't mean too much. Is that right, Don?

DR. MOUNT: Yes.

MR. POWERS: We also had plots put together for April, May and June just to check the normality of our data at this particular station. You can see that there are a few values on the low end which don't quite fall in, but generally it is a fairly straight line.

And July is even a better month at this particular station.

DR. MORRIS: Is that St. Louis?

MR. POWERS: Yes, this is all East St. Louis. I just took it for one station so it wouldn't confuse you.

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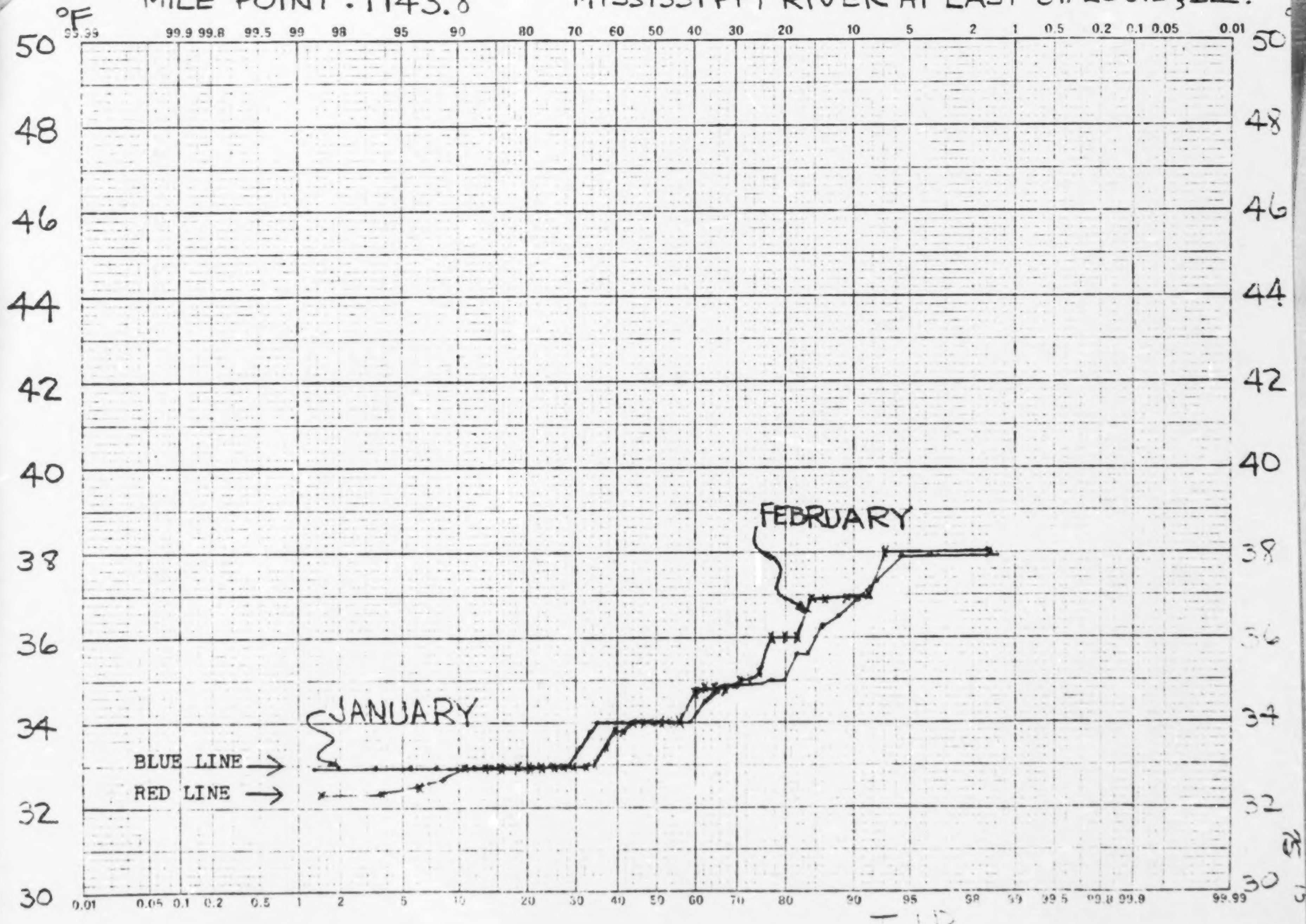
MILE POINT: 1143.8   MISSISSIPPI RIVER AT EAST ST. LOUIS, ILL.



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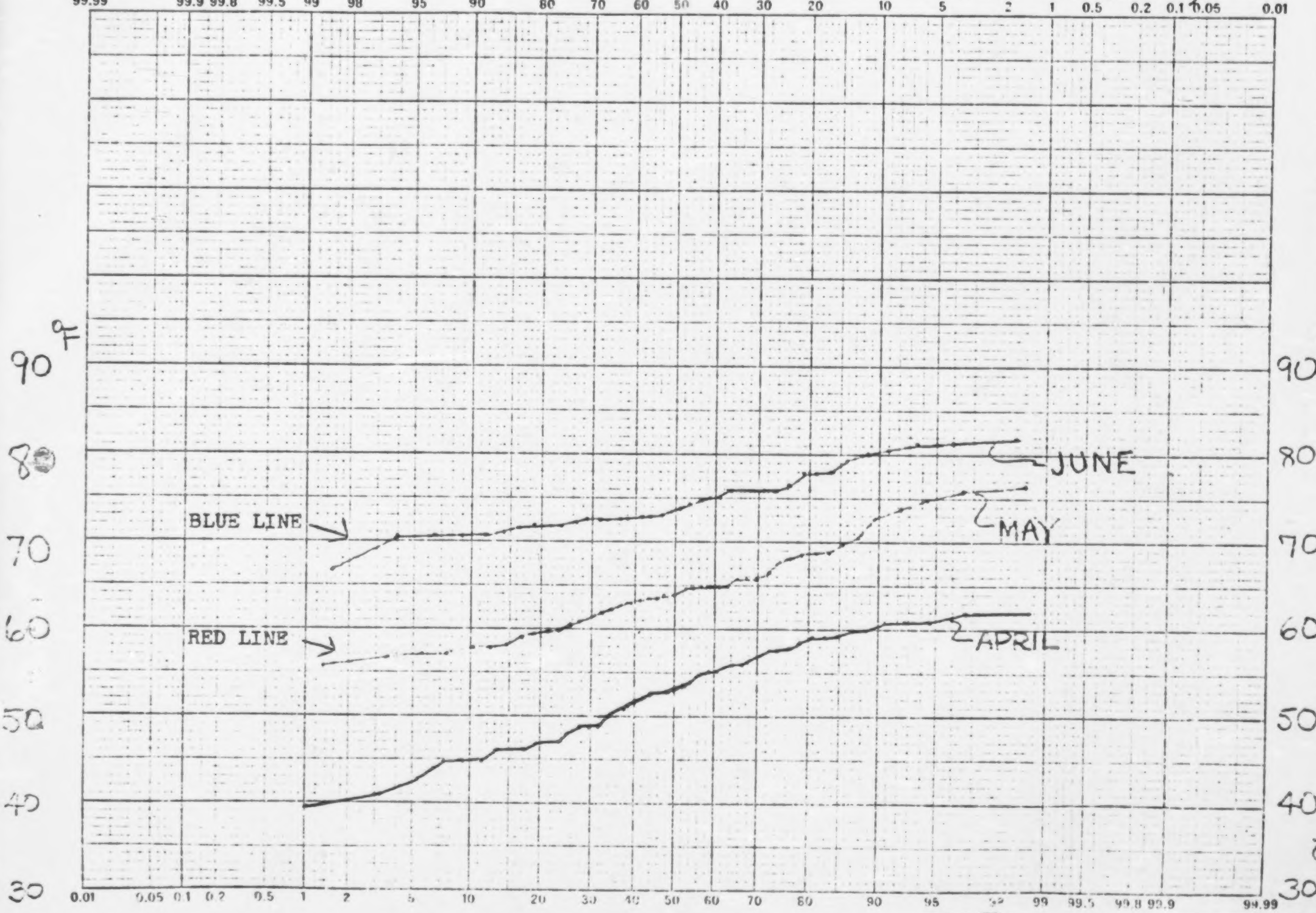

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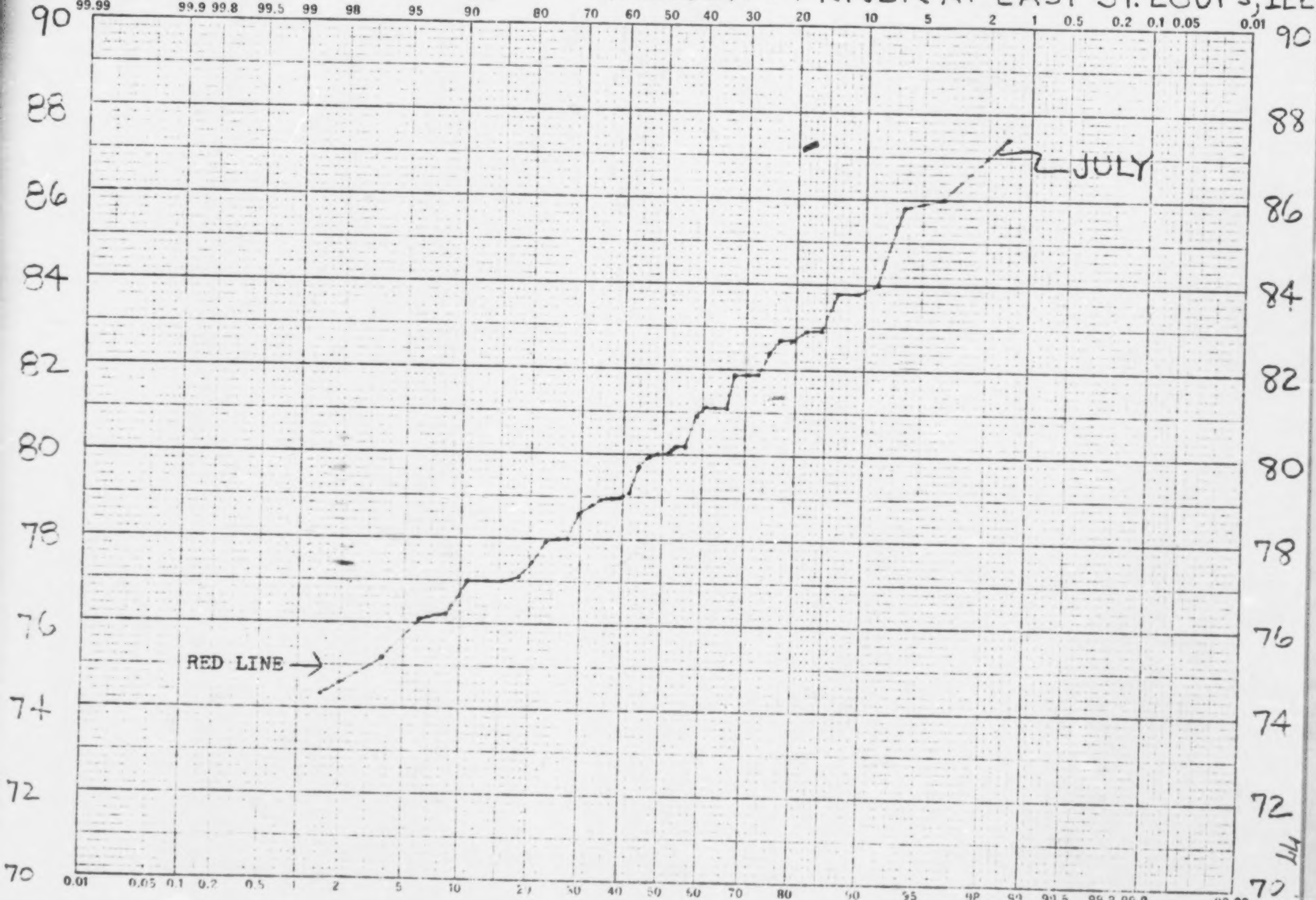


—1P

This shows July as pretty much of a normal distribution, being pretty close to a straight line for all the period of record at that station.

We also made some month-by-month plots of the total data that is in the summary. I will just show you one here for the month of July to give you an idea. We will probably look at this later.

MR. DICKSTEIN: Tom, this reflects all data, State and--

MR. POWERS: Right, this is all the data pulled together from the States, the Federal people, everybody, and it is plotted on the bottom, the river miles above the Head of Passes, which is down in Louisiana, all the way up to Minnesota, and you have got your various zones indicated up here on the top and also the maximum, this is the maximum monthly values for July that have been observed and we notice a few stations are always above the line, we don't know why, but maybe we can get some of these answers today.

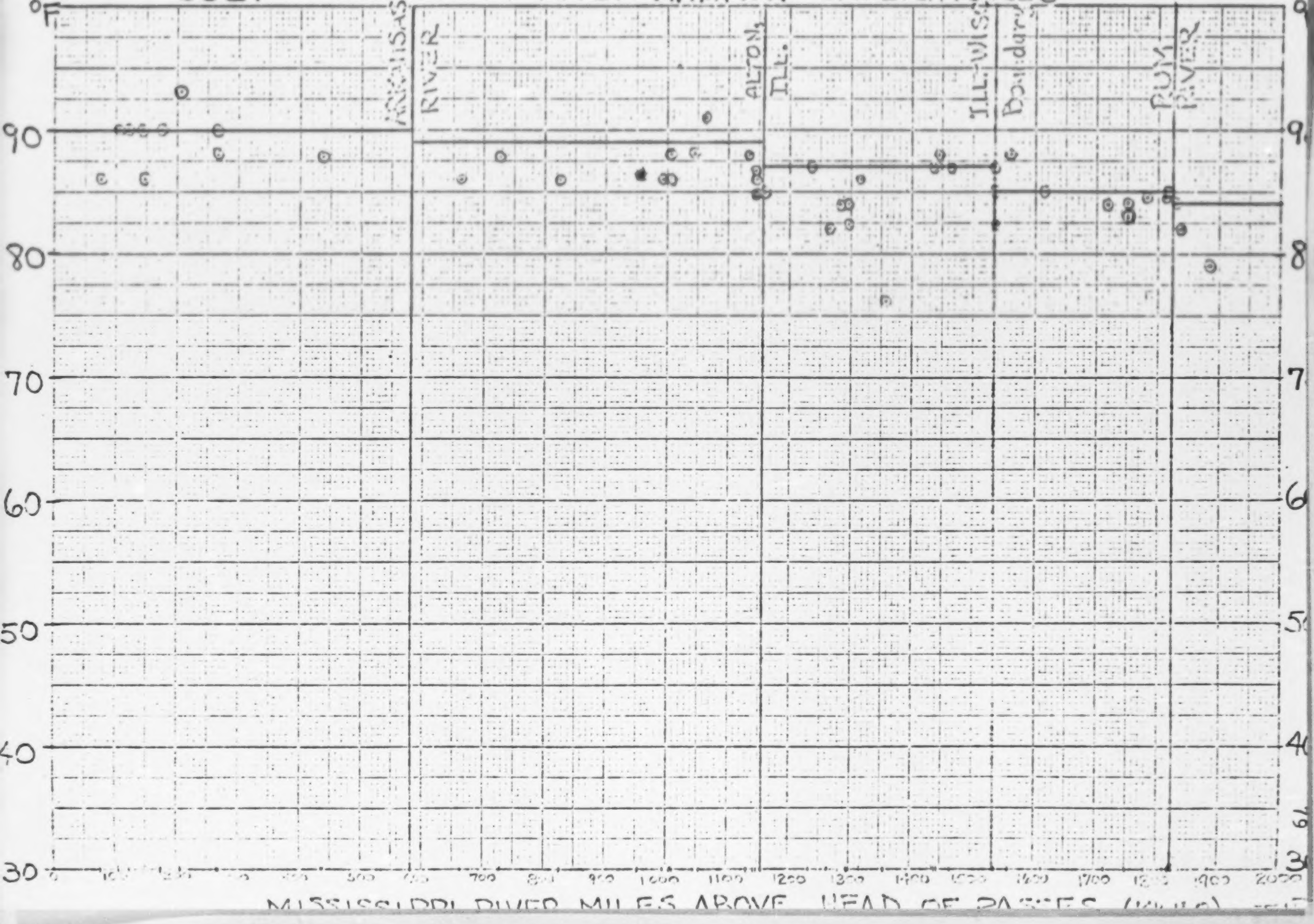
So that is about all I have.

Are there any questions on the summary of the data? We have about roughly 50 data stations that have at least 50 values or more.

MR. MARTIN: Would you care to identify or could you identify the station in relation to the stream cross section? Is this one foot deep or is this--

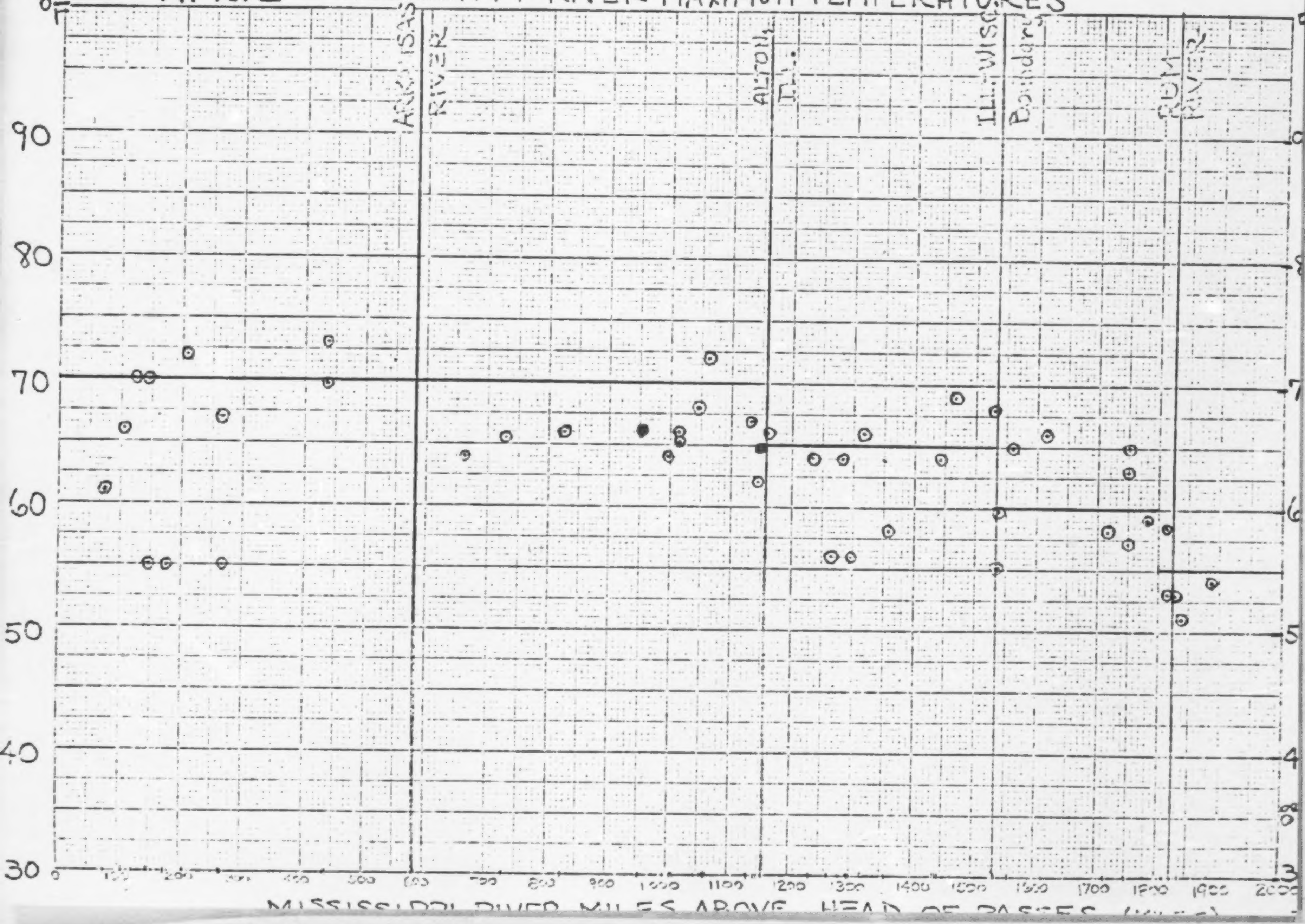
20 X 20 TO THE INCH 46 1240
7 X 10 INCHES
KEUFFEL & ESSER CO.

JULY MISSISSIPPI RIVER MAXIMUM TEMPERATURES



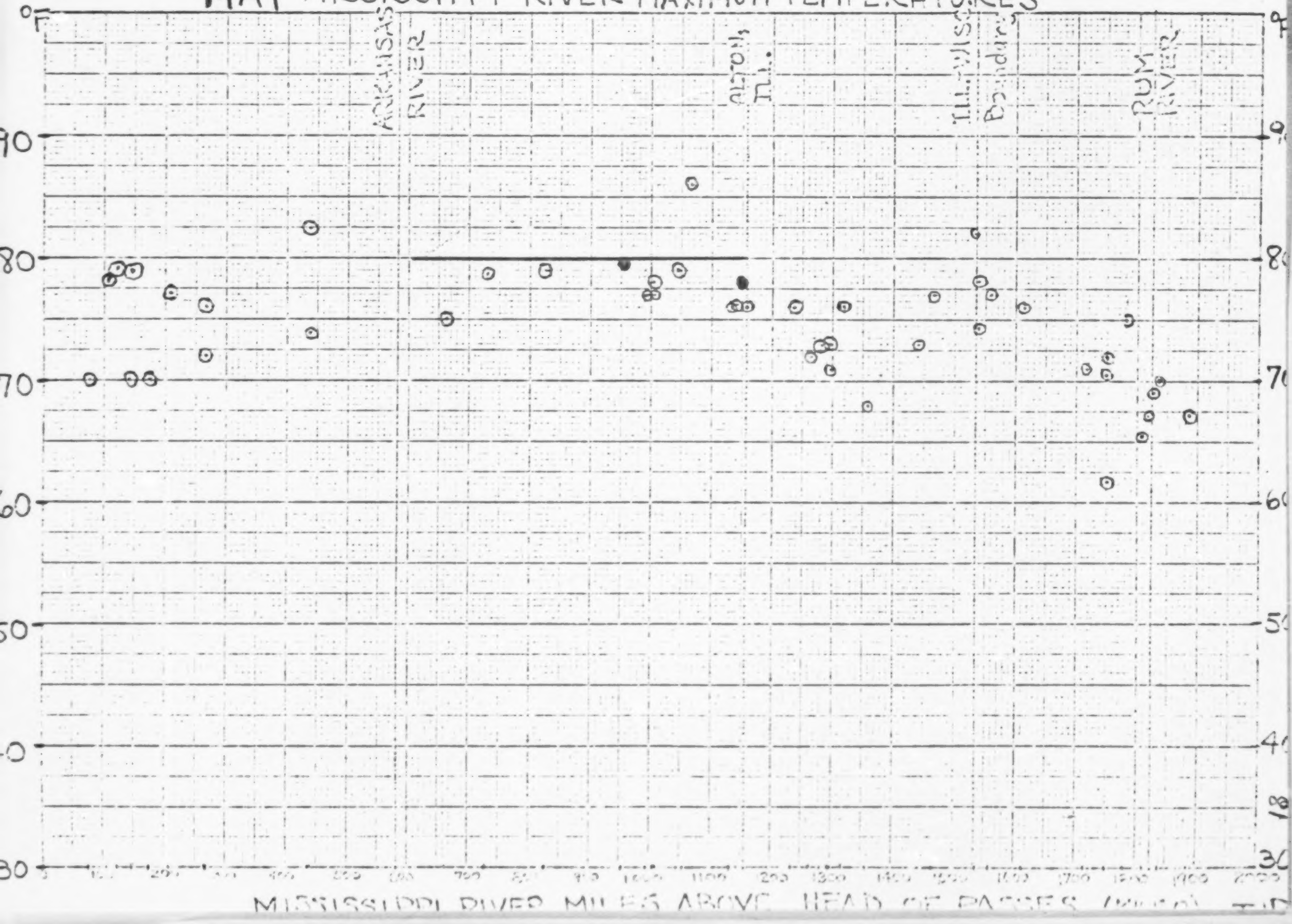
20 X 20 TO THE INCH 46 1240
7 X 10 INCHES
KEUFFEL & ESSER CO.

APRIL MISSISSIPPI RIVER MAXIMUM TEMPERATURES



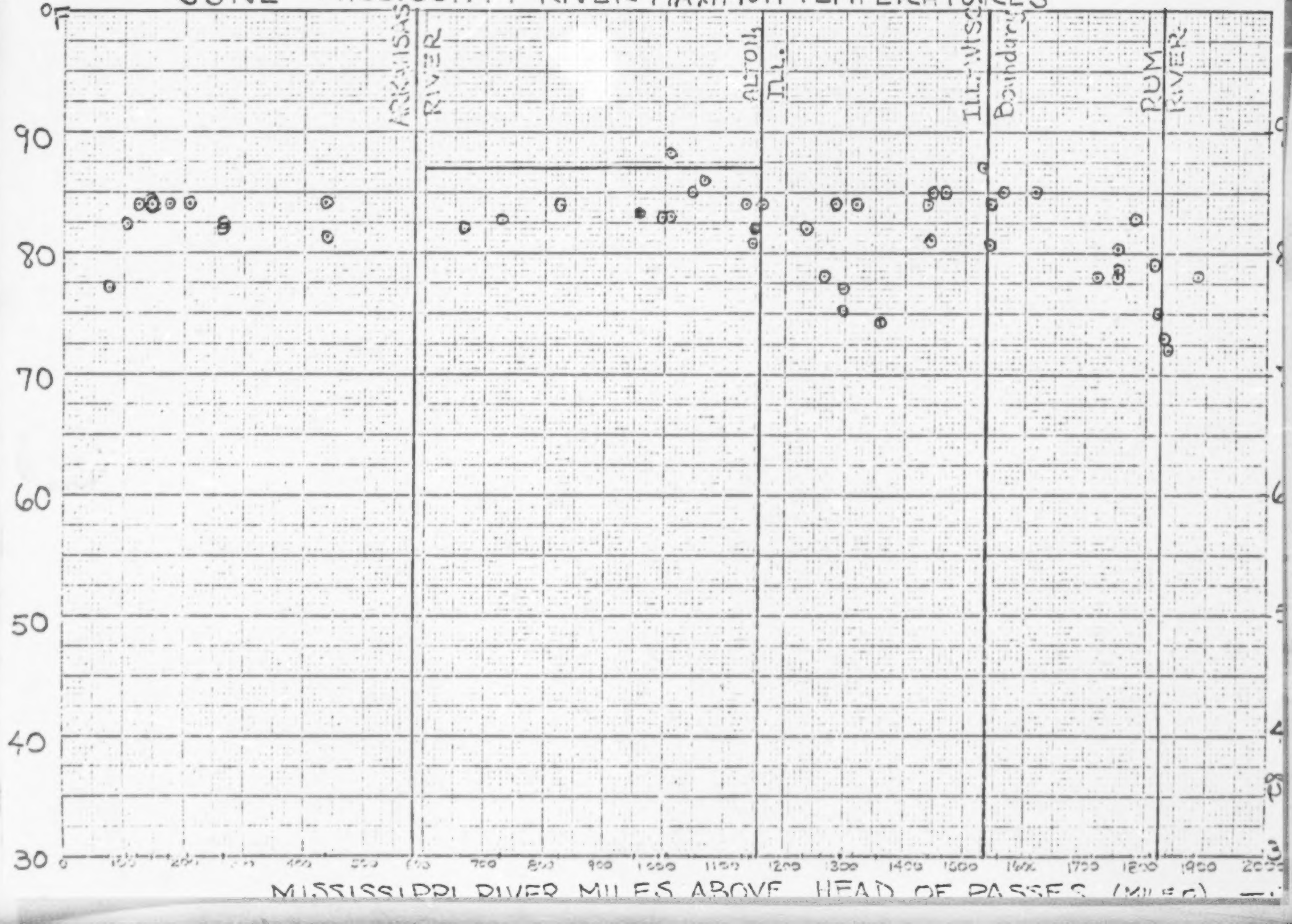
K+E 20 X 20 TO THE INCH 46 1240
7 X 10 INCHES
KEUFFEL & ESSER CO.

MAY MISSISSIPPI RIVER MAXIMUM TEMPERATURES



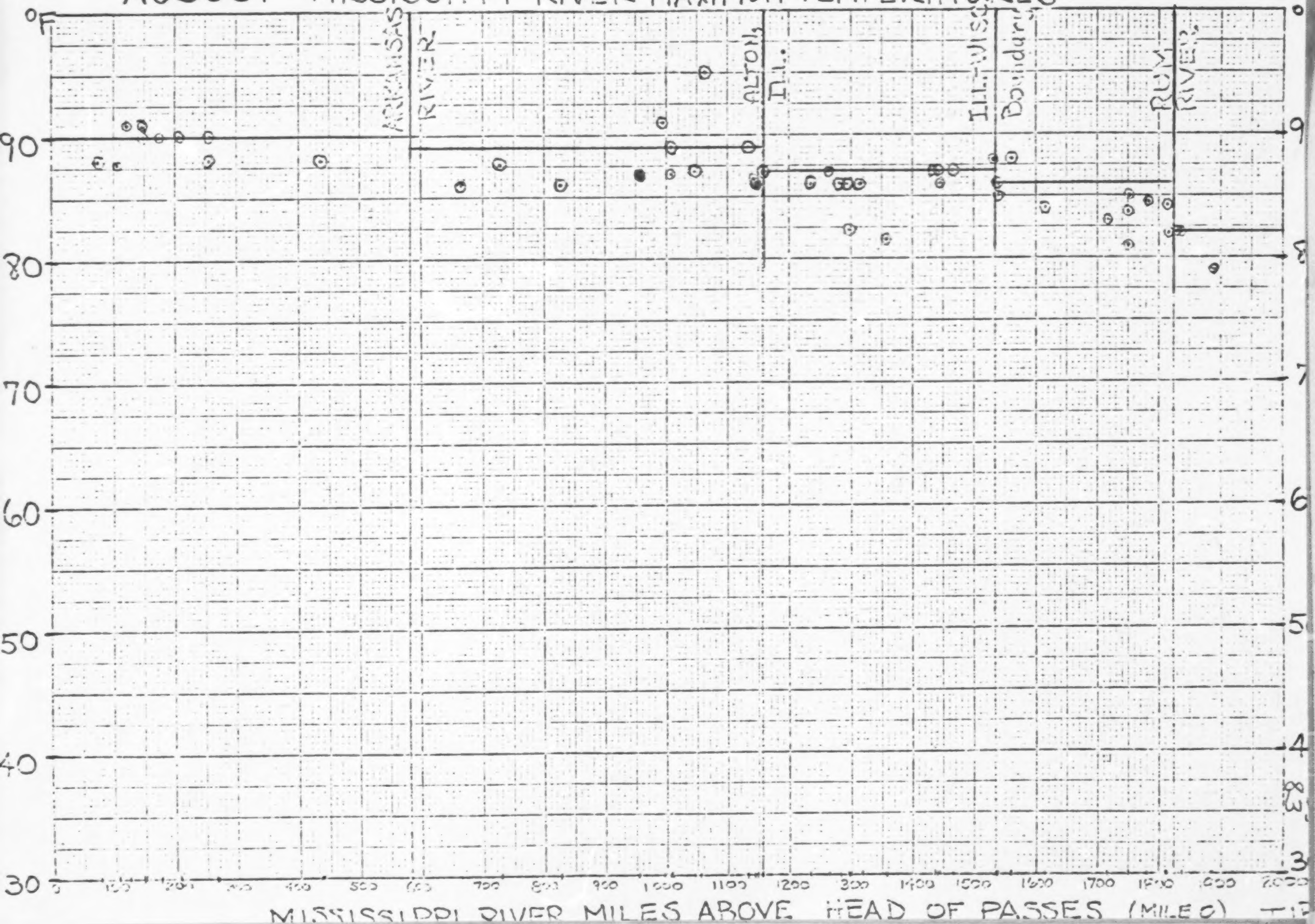
20 X 20 TO THE INCH 46 1240
KEUFFEL & ESSER CO.

JUNE MISSISSIPPI RIVER MAXIMUM TEMPERATURES



20 X 20 TO THE INCH 46 1240
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

AUGUST MISSISSIPPI RIVER MAXIMUM TEMPERATURES



MR. POWERS: No, this is--

MR. MARTIN: --in the center or how are the stations located, please?

MR. POWERS: No, these are not identified specifically in the data that was submitted to me. The only thing I could do was index the data on the river mile as close as I could. Some of them have question marks behind the--so I am not sure exactly where the intakes are on some of these structures. But I estimated as close as I could so we could get it in the ball park and we could talk about it then. If you know specifically where it is on the intake, why, we could probably note that.

MR. MULLICAN: I didn't understand the number of years you said this data covered.

MR. POWERS: Well, it varies. We have stations from the powerhouses dating back to, I think, '51. There is one continuous station on the Mississippi River that has 70,000 hours of record and there are other stations where they might have only taken 7 samples in the total period of record for that month.

MR. MARTIN: The root of my question was based on the sampling station that is in West Memphis, Arkansas, which is on the opposite side of the river from Tennessee or Memphis. Of course there it seems like if you just have one station you would really not have a representation of temperature because you are on the opposite side of the river from the city of Memphis.

MR. POWERS: All right. Well, I did try to indicate the city that the station was located in and it is going to be--some are on the right side and some are on the left, so--

MR. MARTIN: My main question is, in your opinion, is this data sufficient to predicate what we are trying to do here? I think that is really my question.

MR. POWERS: I think generally it is in the northern part of the river. I think we have more data in the northern part of the river than we do in the southern part, and I think this shows up in our summary what we got.

Yes, sir.

MR. HARRISON. Maybe you answered my question; if you did, I didn't understand it. Just exactly where are these temperatures taken at a station? This isn't a cross-the-river sample, is it?

MR. POWERS: No, generally--

MR. HARRISON: Does any of this reflect channel bottom temperatures, surface temperatures of the channel, side channel temperatures, and so forth, or is it just one particular place where you have taken a number of samples over a long period of time?

MR. POWERS: Well, I think perhaps Red Wing, Minnesota, would answer your question. We have got three different locations at that particular station.

Do you want to tell us about the STORET station? Would you give us a little background?

MR. BRYSON: The STORET station at Red Wing is located upstream from the lock and dam above the influence of-- the flow pattern over the container gates, and so on, as sampled at a depth of three feet with the intake jutting out into the river getting a representative sample. We have taken cross sections of different depths, and so on, to make sure the temperature is representative.

MR. HARRISON: It seems to me this is the way the temperatures ought to be taken, but I would question personally temperatures or any number of them, 70,000, if they come from one particular place on the river. I don't think that reflects the river temperature.

MR. POWERS: Right. Well, this--

MR. STEIN: Let me try to outline the question as I see it. I think Mr. Martin was looking at the question as perhaps I look at it or as we formulated it last time. The question here is we are trying to deal with the data we have available at the present time or from historical records and see if this is adequate on which to base a judgment, and I think all the factors ought to be taken, one the accuracy of taking it, where you took the samples, and so forth.

Last time we discovered that the computations by our people were based on material based in a computer system we have in EPA called the STORET system. A lot of the States indicated that they had data, temperature data, which was not included in the analyses. Therefore, the last time we decided that it would be worth while to go back and try to plot these again, not only using the data that the Federal people had in the STORET system but also utilizing any State data which was available.

I think it is fair to say that since we have not embarked on a study or taking cross sections of the river and taking all this data and analyzing this in this sense and we are largely going back to historical records, that some of the data is going to be better than others and some people may have philosophic or scientific questions about how the sampling is taken or whether it was taken correctly or not, and so forth and so on.

I think your question here is, and let me see if they have done the task, that every bit of temperature data that is available from the States and from us has now been put into this operation. The judgment we have to make and I think you have to make is if based on this we can come up with a basis of judgment so we can come up with some kind of figures to regulate temperature rise in the river. I think we are faced with the notion that we all have temperature standards in all the States and if the data is inadequate, I guess we should know it. I thought the purpose of the exercise was to try to get every available bit of data into this to make this basic computation as perfect as possible, and again to recap what has been done, we made an original computation based on Federal STORET data, this computation was made on all the temperature data available in the Federal STORET system and in the State files which was available.

O. K., is that a fair statement?

Go ahead.

MR. MARTIN: One other comment and I will keep my mouth closed.

I think we all look for numbers. In other words, a statistician has to have so many figures in order to predict something. But if the method these numbers were obtained from is not a cross section, then the numbers, in my opinion, are really not as meaningful as they should be.

MR. POWERS: I agree with you. Generally we don't really have control. A lot of the State health departments are in on collecting these samples and the analyses, and whether there is uniformity State to State is hard to say, I think.

MR. STEIN: I would doubt that very much.

Again I think you have to approach what we have here and your points are well taken. The data that was used is just what was done in the past by the States or the Federal people or a water plant or some powerplant or some kind of operator by whatever method he used, we used every one. Some of these may be cross sections, some may not. In a good many cases I take it we don't even know. But we have used the figures.

The question I think you have to look at, when you plot the curves and on the basis of your experience, we have two choices. Either we go along with this or we embark on a survey to get more meaningful data. The reason we thought that the approach would be to take every available piece of data and put it together is just coming up with a methodology on a survey isn't going to give you the answers right away. You need time and you need a long time in order to get meaningful temperature data to really project.

As administrators you are faced with the problem that you have to regulate now. Now, maybe we should embark on a program, but I am not sure we can wait 5 years, 10 years or 20 years to get temperature data in before we begin to regulate and these are the problems we have.

Yes.

DR. MORRIS: I would like to offer this comment on the problem of point sampling and grab sampling for temperature, which is what this really is. We have done some continuous sampling work in the Dubuque area and all along the Iowa reach of the Mississippi, and I would like to defend a little bit the data that is being used here. I don't think it is as bad as might be inferred here, because in the two summers that we have done continuous monitoring we have only found about a 2-degree 24-hour difference in the Mississippi River in the flowing part of the channel where we measured. We didn't get great fluctuations. So I think the values that this gentleman reported has that validity to it.

There is a difference in our part of the river where you measure, those daily differences fluctuate more as you get into the backwater, but as long as we are talking about the flowing stream itself, I think the temperatures measured in the Iowa reach, at least, are relatively valid, although they may not have been collected over enough years. But I don't think it is in our part of the river so important exactly which depth you measure at.

MR. STEIN: Thank you, Dr. Morris. I think those points are well taken.

In taking this as a nonspecialist, I should say, in the field, the thing that impresses me about the data, recognizing the problems we have about this, is the plot of the curve. In other words, I think you are coming out with a reasonably straight story and if there were wide fluctuations you couldn't draw a line like that. But this is a judgment you have to make.

Again let me say the alternative, as I see this, if you don't consider this adequate and unless you make the assumption that Dr. Morris made that these grab samples are pretty well reflective of the situation as we know it, it would seem to me that the kind of perfection we are talking about here is going to require putting up a very detailed study over a relatively long period of time. In other words, we can't produce that within the next month or two or perhaps within the next year or two. There is no substitute for time in getting this, so you are going to have to make your judgment whether you are sufficiently confident with these analyses to go ahead and have a temperature requirement.

Yes.

MR. SMITH: We would agree with Mr. Morris of Iowa that these temperatures are fairly representative.

MR. STEIN: Are there any other comments on the temperatures before we go on? Does anyone else want to say anything?

Let me again summarize. I think we have done what we possibly could do to improve the temperature projections. That is, when we were at the first meeting the States pointed out there is a lot of data in their files which hasn't been used in these projects. We took them and put them in. Now, I take it there is no other way at the present time that we can perfect this, really. Ultimately you are going to have to make a judgment on this.

I will give you my personal feeling. I think we are going to have to come up with some kind of temperature regulation one way or the other and I think we are going to have to put it on the basis of existing knowledge.

I have been in the regulatory business for a long time and I remember when we started in radiation we didn't have even this kind of information. In other words, when there is a demand for regulation, you are going to have to do it several ways, either you are going to have some thorough data, which you almost never have over a long period of time, you are going to base this on professional opinion, or you are going to have a sufficient amount of data based on various checkings and experiments and over a prolonged period of time where you can make a reasonable projection. I think more or less in this temperature field on the Mississippi we are in that middle course. We are not in a position where we can definitively have cross sections of temperature on a 24-hour basis over, say, a 10- or 20-year period nor are we so deficient in data that we have to just rely on professional judgment, but we are in the middle here. We have put everything we could put together and as far as I see it, the States and we are in the same spot, we are just going to have to bite the bullet and come up with a regulatory program on temperature control, we are going to have to do the best we can with the data here, and I don't consider that we are too unfortunate. I have been in a lot worse situations.

Are there any other comments on this?

Well, if not, perhaps we can go with the next point. Do you want to do this?

MR. DICKSTEIN: Yes.

To summarize the biological data and incorporate it to some extent with the temperature data, biological recommendations were questioned at the last meeting and we thought it would be best to bring our biologists together, the Federal biologists and the State biologists, so from here on out we look on it primarily as a biological meeting.

We would like to start off with Dr. Don Mount, whose group prepared the overlays for protecting a particular species. And Don would like to explain this as well as other biological problems.

Don.

MR. STEIN: Biological meeting? The boys outnumber the girls here. (Laughter.) You know, I was thinking about, looking at Tennessee, years ago I was flying in a DC-6, to tell you how long ago it was, and some old gent from Tennessee who was in the airplane came up to me, he was a tobacco farmer, and he kind of chatted, asked where I worked, and at that time I was with the Public Health Service, as I guess a good many of us were, and he said to me, "I am glad to meet a man from the Public Health Service. I always wanted to meet a man from the Public Health Service." He said, "Do you mind if I ask you a question?"

I braced myself, there was no place to go, and I said, "Yes, go ahead, ask me the question."

So he said, "Who do you have more trouble with, the men or the women?" (Laughter.)

I didn't know how to field that. I looked at him and I said, "About the same."

He says, "I thought so." (Laughter.)

DR. [illegible]ONALD I. MOUNT, DIRECTOR
NATIONAL WATER QUALITY LABORATORY
EPA - WATER QUALITY OFFICE
DULUTH, MINNESOTA

DR. MOUNT: Only a balding lawyer would make an observation like that, that is all I have to say. (Laughter.)

Well, I feel like it is kind of presumptuous for me to even talk about temperature. It seems to me like this is all we talk about around the country and there is nothing but disagreement about what is good and what is bad and what ought to be.

I would like to reemphasize one point that Irv made, that our staff's input for this thing that you got last time was confined to the dots on the overlays. We did not recommend to you States what fish you ought to protect. It is not our position to tell Minnesota that they ought to grow carp nor Louisiana that they ought to grow northern pike. This was not our decision nor our input nor were we requested to do that.

Secondly, our approach to make recommendations on a question like this is somewhat different, perhaps, than is often followed in the regulatory agencies in that the question that we ask ourselves first when we are considering limits of anything is not what is there now, but what are the uses, in this case what kind of aquatic life is it that we are trying to protect, and then we try to go see what that kind of aquatic life requires in regard to temperature, zinc, or whatever it might be.

I am not suggesting that you don't have to look at existing temperatures too, but what I am saying is, the first question we ask ourselves is what does that aquatic life require in our best judgment. And that is the question that I propose to speak to this morning. And I am a little bit confused as to just how to go about this because it is primarily a biological meeting and yet I see a lot of people sitting around who I know are not biologists, so I think maybe we ought to kind of review some of the considerations that have to go into this determination.

I would like to mention, before I forget it now, that the dots on these overlays, and we are going to look at these in a minute, were made before we ever saw the temperature data in the Mississippi River. So if there is disagreement, it means perhaps that we don't know what we are talking about or something is wrong with our numbers. If there is agreement, if it agrees with what is there, I think it is a suggestion that maybe these values are reasonable.

A few comments, I think, are really pertinent to coming to grips with this question of temperature standards on the Mississippi and one of these is the often made mistake which I have encountered in working around the country and that is that our standards that we are talking about, at least as I understand them, are receiving water standards. This means these are temperatures that are acceptable for wide reaches, long stretches of the river, and that we are not just talking about the locale of the discharge. I think all the biologists can recognize that you can do things to a small segment of a stream, a few hundred yards or a mile or something, and tolerate conditions there perhaps without significant damage that you can't tolerate in a whole reach of the river, and so the numbers that we should come up with for standards I think should be protective if those conditions existed throughout the river and not just in one spot or for long reaches of the river.

So I think this is a real important consideration when looking at existing temperatures and existing observations on the biota. Yes, you may have found a largemouth bass at 100 degrees Fahrenheit, but because you found him there once doesn't mean that 100 degrees Fahrenheit is good for the entire river or for an entire reach of it. But I think we often make that mistake.

I liken this to a traveling businessman in the evening. You find them in bars and other places which they can survive for a short period of time but which they can't take for a long period of time. (Laughter.) And I think fish are in the same category. They have their bars too.

And this, of course, bears on the concern that whether or not a temperature is lethal has to depend in part on how long the animal is there. I suspect that you can put a fish through 150 degrees Fahrenheit if you don't leave him there more than a fraction of a second, I am sure you could, without harming him much, but you do have to consider how long it is there as well as what the temperature is before you can really arrive at any meaningful understanding of what it means. I recognize this is probably insulting the biologists, and yet I think a lot of us forget this when we are talking about maximums and means, and so on.

Another point which I feel that we have come a long way on in the area of standards is the recognition that there do have to be annual cycles in temperatures, at least for some kinds of aquatic life. There was a time not really very long ago when a temperature standard was thought to be a single value that was applicable any time of the year and that, of course, was based on what could be expected in the summer months, perhaps in August. We are doing a fair amount of work now at our lab in Duluth taking a look at this winter chill requirement because it does seem to be a rather important time for some kinds of fish. In a minute I am going to pass out to you some literature references or abstracts, rather, and one of the last ones in there, I think it is near the end, lists a whole flock of species of fish which have been found living in a constant temperature spring in Florida. This kind of information tells us that those fish do not have to have a chill period in the wintertime. On the other hand, we are conducting work right now at Duluth on another species of fish where we have clearly demonstrated that they must have a chill period in the wintertime in order to initiate reproduction and we have found in our work so far that how long they have to be chilled depends on how cold the temperature is. If it is colder, they don't have to be cold for as long a period, a completely reasonable expectation if you think about it, but this kind of information has not been generally available to document what kind of numbers we should have in the wintertime.

I think a second thing which people have recognized, and we have been trying to propagate the idea, is that hot temperatures around a discharge in the summertime are really not of that much concern in terms of fish kills. I am speaking now only about kills of aquatic life, particularly of fish. And the reason is that fish avoid these hot water areas if, of course, there is a hot place to go.

I think this again is completely obvious if you think about it, but what we do recognize, I believe, is that the important time as far as fish kills are concerned is in the winter, because the fish we know are attracted to these warm plumes and they do feed there and they do provide very good fishing in many cases. But if the plant closes down, and I am not talking about a one-hour shutdown, I am talking about a plant or in-plant shutdown that may occur over several days, these fish become acclimated to perhaps 20 or 25 degrees higher than the river temperature normally is and if they have to return to the existing temperature, this is the time when they are likely to get wiped out if they do at all.

And so we believe, therefore, that the permissible temperatures in the wintertime need to take into consideration this drop that the animals can tolerate. Right at the present time we have a field station set up at a powerplant upriver on the St. Croix from Minneapolis where we are working with this very question, how much of a drop can these animals stand, and as you would have guessed, of course, different fish can take different drops, but we have just completed a series of tests on smallmouth bass and we find that they can stand a drop of about 15 degrees Fahrenheit with no adverse effects, no apparent adverse effects, but if you drop them 20 degrees Fahrenheit, and this is a very sudden drop I am talking about, they are likely to live through the 7-day test period, but if you hold them another 7 days most of them die. Well, this, then, gives us a clue as to how high you could raise the temperature in the winter and what drop you could tolerate if the heat source went off, and we think this is really valuable information to have in terms of assessing this winter condition.

I would like to show you a few slides just to give you a little feel for some of the things that we have been doing.

This is an apparatus that we are running through a lot of species of fish, the eggs and fry, to determine the acceptable temperatures, the high acceptable temperatures, for egg incubation, hatching, and the first four weeks of fry growth. And we have put through, I guess, six or seven species of fish now, like the northern pike and the yellow perch and white suckers and herring and other fish, bluegills, I believe, other fish that are important and that we have very little information on.

And the kind of things we see are normal sac fry, of course, coming from the good temperatures and we see these kinds of deformations if the temperature is just a little bit too high. I will show you a graph a little bit later made from this same experiment to show you how close a temperature that produces this kind of effect is to one which produces very good growth, that the maximum temperatures that they can tolerate are not very far from the temperatures where they grow best.

Here is an apparatus that we are using right now on this chill requirement and this is a very complex statistical design and involves a lot of tanks, but we are able to get at this question of how long does a chill period have to be and how cold does it have to be in order for these fish to spawn.

Now, this will illustrate what I was talking about a minute ago in that-- You can kind of ignore these titles; they weren't prepared for this kind of an audience. But what I want to call your attention to is the very sharp drop that you get

Dr. D. I. Mount

right after you have reached the temperature of best growth. The top of the line, of course, represents where you had the best growth of the species of fish. This happens to be the largemouth bass in the red line and isn't even our data, as a matter of fact, as you can see. But the point I want to make is that there is only a few degrees difference between temperatures of best growth and lethal temperatures.

And so this means, then, that if we want to have maximum growth we are going to be riding the threshold pretty close and this means that there are times, then, when temperature control becomes really critical if you are going to keep things in good order.

This is some work that Dr. Brungs did at our field station in Ohio where we held minnows at constant temperatures and looked at their reproductive success, and I think it is rather remarkable that here the fathead minnow, one that we usually think of as surviving in pretty warm waters and does, in fact, live in ponds, if it is maintained at these elevated temperatures very long you can see that the young produced, the reproductive rate, slows considerably.

Here at a temperature of 75, it happened to be the control temperature, we used that as unity, 100 percent, and even going up as high as 79 or so, you see we get a measurable reduction in the number of young produced and their growth rate.

Going up to--what is this?--about 82, you see, we are down about 50 percent of what they could take up here.

Well, this, then, says that if you are maintaining constant temperatures, which, of course, you don't do in the river, but that these high temperatures do have importance and this kind of data compares very favorably with what we see in our hatchery ponds with fatheads in that in July and August particularly, if you go down there on a hot summer afternoon or during a hot spell, you will find that the fish are not spawning. If you go down during a cool period, they are spawning. And so I think it fits with what we have found here in the laboratory.

This is a--don't get upset about where the lines are drawn on this thing. Let's just forget it is even smallmouth and talk about the concept of the geographic range here. The point I would like to make is that a lot of our fish species that we are concerned with in the Mississippi have the southern limit of their range somewhere in the drainage basin, and this obviously means to me, then, that the amount of heat we can add down in here (indicating) for this species of fish is going to be a lot less than it is up in here (indicating) somewhere.

Now, again, a perfectly obvious principle, but if we are talking about some incremental rise over ambient, it begins to have importance in that connection.

A 5-degree rise here on the southern edge of its range may mean that the river is no longer suitable for that species. On the other hand, up in here (indicating) somewhere a 5-degree rise may mean that it is better suited for that species.

And as I say, the point I would like to emphasize is that I think we have a lot of important species that have their breaking point somewhere through the middle of the continent and this is going to be pretty important in establishing the standards and I think is the reason why we do perhaps need to have some zones identified in the river.

Oh, yes, I put this in just to remind me to mention that there are lots of sources of heat. This is an example of what the temperature of a stream did. This is before logging and this is after logging. We have already had a lot of this kind of heat input to our streams and I am not saying there is anything we can do about it, but the fact of the matter is there isn't anything the fish can do about it either and the heat is there and whatever we add is going to be on top of that.

So while I guess we can't change God's plan nor what man has done in history, we have got to take it into account in determining what we do from here on in. I often get these questions from boards when I am making a presentation at a State hearing that, you know, what are you going to do, turn the sun off. Well, obviously we are not going to turn the sun off, but if the sun is going to shine we have got to consider that as a source of heat as well as whatever else we put in.

[illegible] I think I would like to go to those overlays, if you could. I am separated from my outline here and I will probably miss a bunch of points. I don't know where to stand.

I would like to make one comment about the curves which Tom showed earlier. Those were curves which he and I decided we ought to do to find out whether or not a standard deviation was a reasonable measure of the spread of the data. And it turns out that, as you might expect, in the wintertime it isn't a very good measure and in the summer it looks pretty good. But I often use the standard deviation as getting some idea of the variability of the data around the mean. And so we did those plots that he showed in appreciation for these curves.

The blue line here is the mean temperatures for--this is a station where, at Red Wing, Tom?

MR. POWERS: This is Red Wing.

DR. MOUNT: O. K., this is up in Minnesota now.

MR. POWERS: St. Paul.

DR. MOUNT: And the blue line is the mean temperatures for the various months, the months on the bottom, the temperature on the vertical scale here, as you can see, and the dotted lines are plus and minus 2 standard deviations and then the solid line below and the red solid line above are the mins and maxes for the period of record. So this gives us a picture of what the

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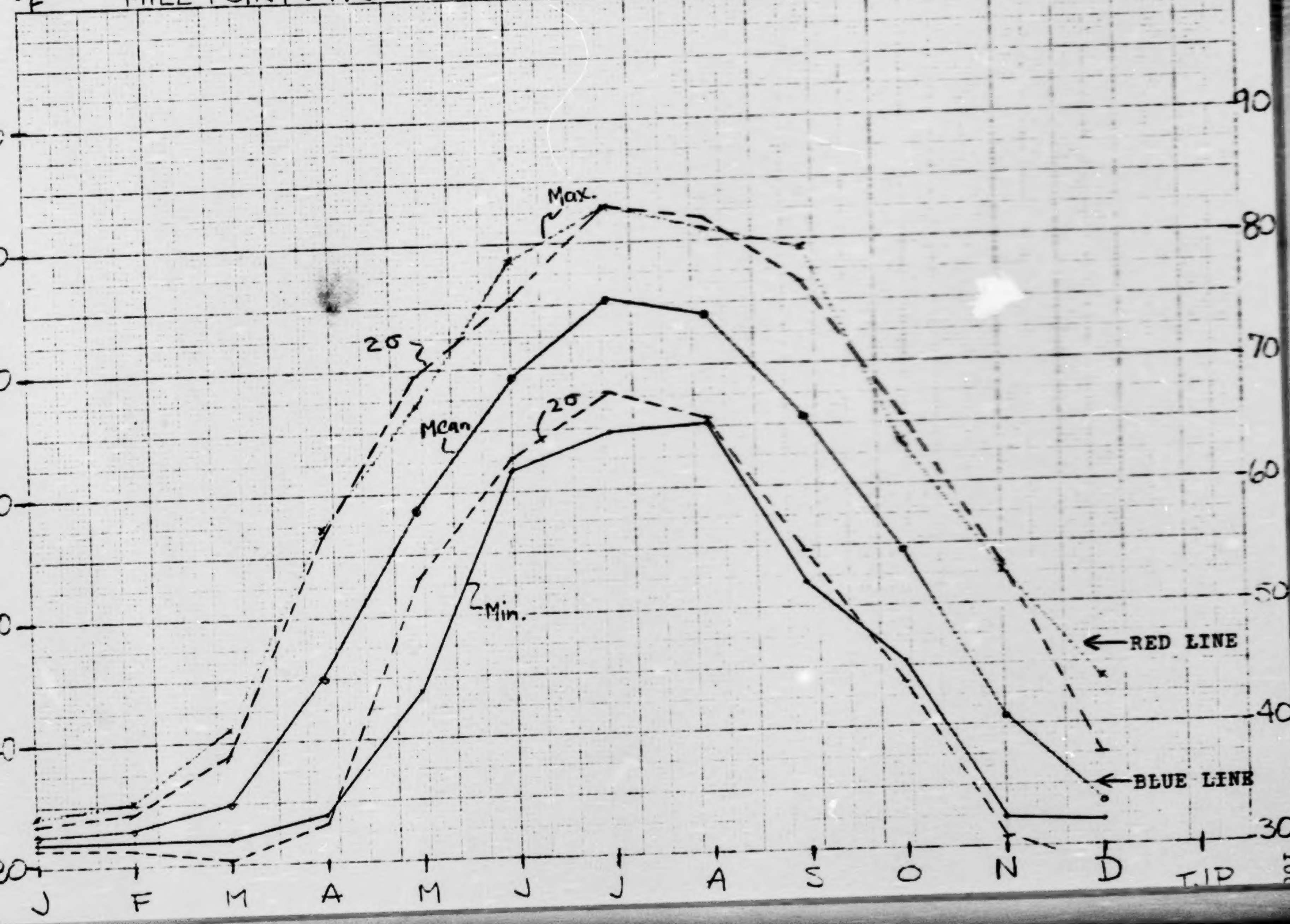
MILE POINT : 1750.7

MISSISSIPPI RIVER BELOW ST. PAUL, MINN.



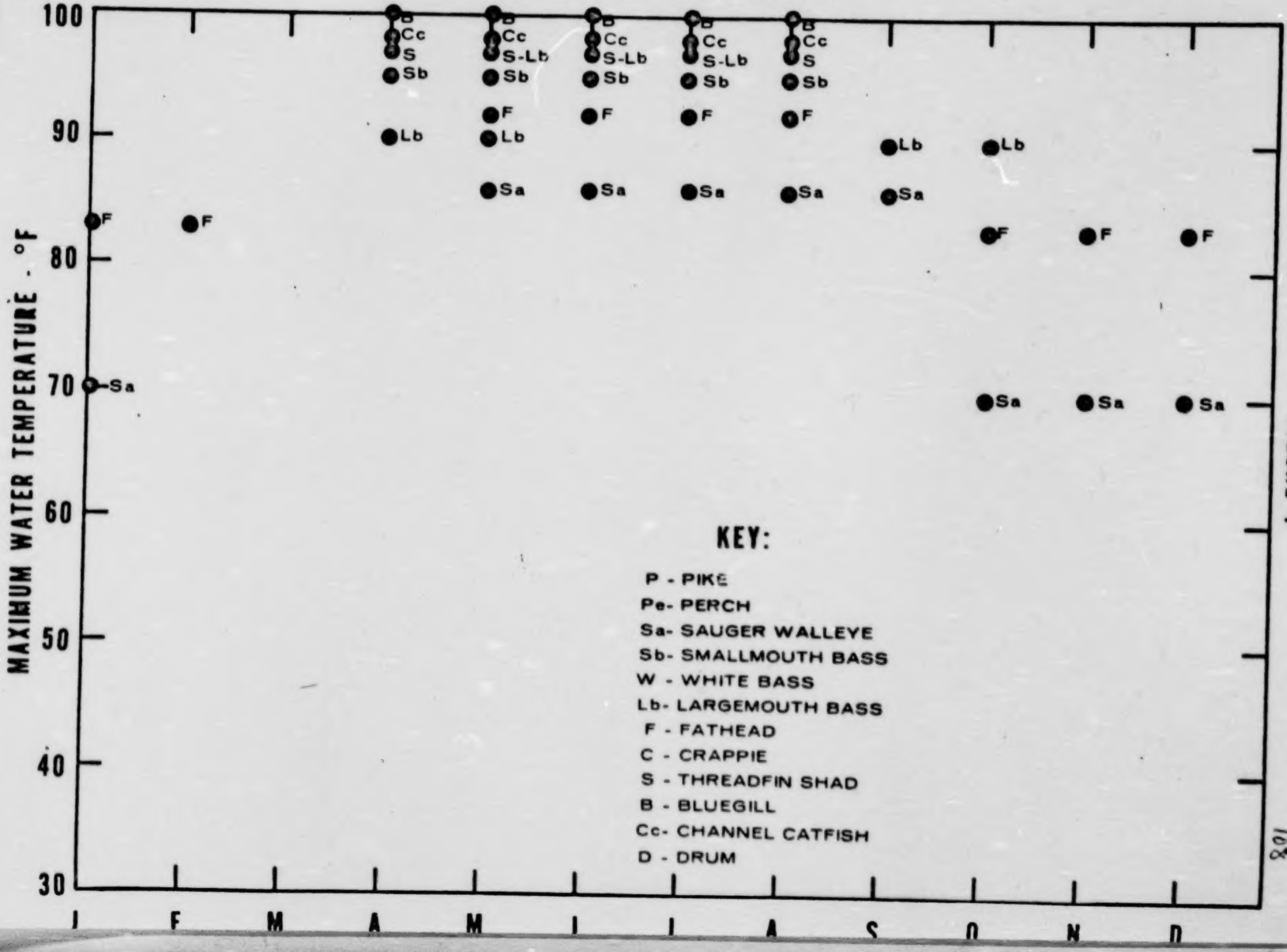
mean temperature is like up there and what the extremes are like and what the spread of the temperature data shows us.

And this is the overlay that was originally included in that first handout. The dots are based on what we think we know and what we can find in the literature about different species of fish, and these are the lethal limits. These are the temperatures above which, if you stay very long, like 24 hours or so, you are likely to get death of the organisms. And it simply says that nowhere here are you really exceeding the lethal levels of these species of fish that are listed on the chart here, and that is not surprising either.

I wanted to mention that we have these dots down here (indicating), and there is one over there which we don't need to look for at the same level, which are there for two reasons--well, the level has been selected based on two reasons. One is that they can take a drop from this temperature down to ambient temperature according to the studies that have been made on those species and we find--there was some work back in the 40's, I believe, in which this kind of a study was made to see how much of a drop the different species could take, and there are some which are very, very tolerant to this drop and it isn't necessarily carp. It may be some very fine game fish, for example, that could take quite sharp drops. And the other reason for having--well, no, that is right, the other comment

FIGURE 4

LETHAL TEMPERATURES



will apply later. So these dots are placed based on this drop that they can tolerate.

Now, obviously if these fish were acclimated to temperatures that exist in the summer, then their lethal temperatures would be way up here (indicating) somewhere. So we are not saying that you can't get this species hotter than that temperature without killing it. We are saying that if it is acclimated to a temperature that exists in the river at that time of the year, then this would be about as high as you could go.

Let's look at the same overlay placed on the next station down the river.

MR. POWERS: This is East St. Louis, Illinois.

DR. MOUNT: Now, at East St. Louis we are, I would judge, and you State people will know a lot better than I because I have not worked in that particular stretch of the river, but we must be getting out of the range of northern pike and some of these other northern species that are important up in Minnesota. Now, let's see.

These are lethal temperatures. This row of dots right here (indicating) are lethal temperatures for sauger. I think those are actually based on yellow perch, because so far as I know there is relatively little data on sauger. They seem to be rearing their ugly heads all the time. Maybe we ought to get

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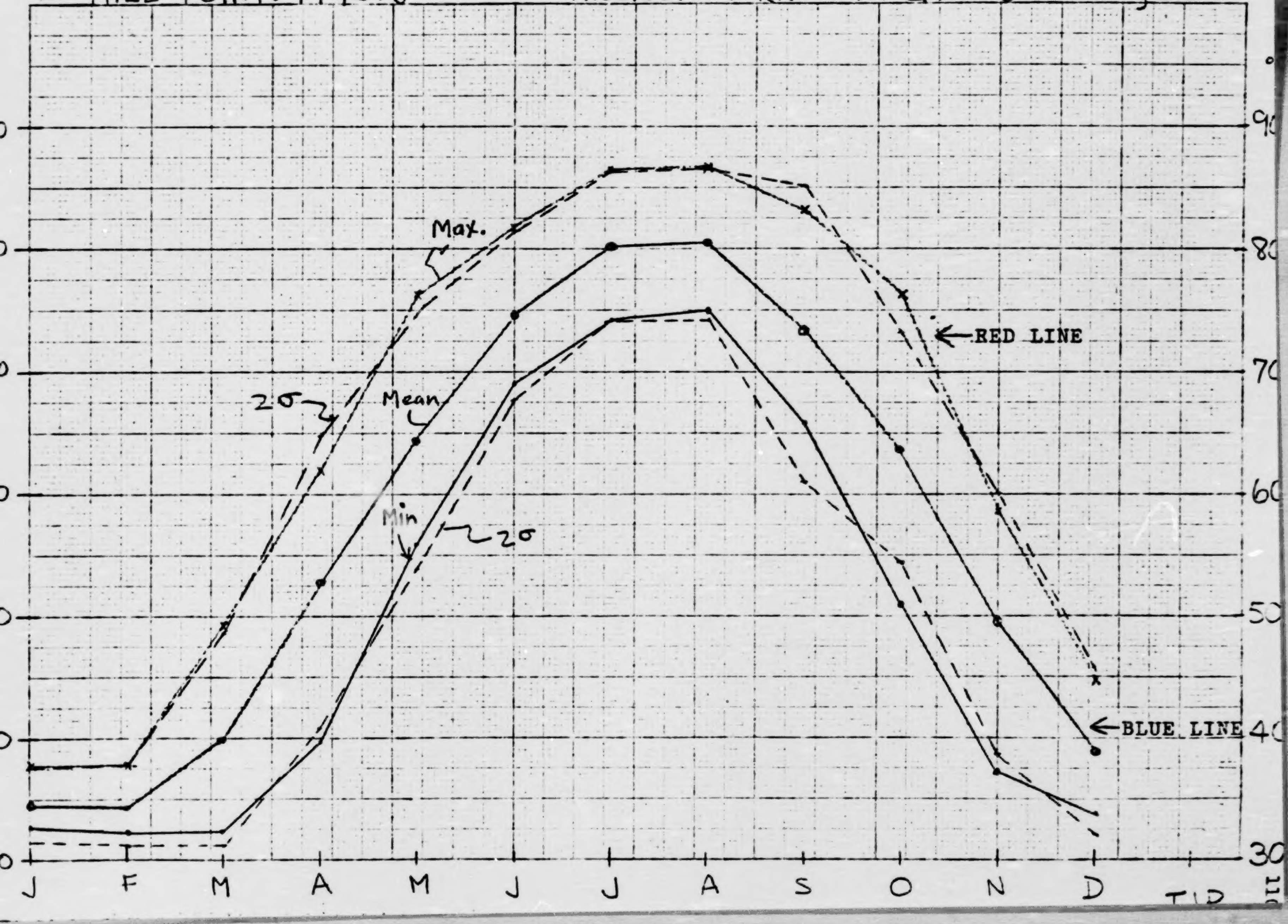
°F MILE POINT: 1143.8 MISSISSIPPI RIVER AT EAST ST. LOUIS, ILL.



something on them.

MR. HARRISON: I didn't quite understand you. You say this is--

DR. MOUNT: This is a plot of temperatures at East St. Louis.

MR. HARRISON: On sauger?

DR. MOUNT: No--well, there are all sorts of species on here.

MR. HARRISON: No, but I mean that one line of dots.

DR. MOUNT: Yes, these are sauger. Now, the question I want to come to is does this mean that there aren't sauger in the river? Well, of course not. To begin with, these maximum temperatures--this temperature pattern depicted by the upper line never existed in any one year because the maximum temperature in June occurred in one year and the maximum temperature recorded in August occurred in a different year. So really never was there a year when the temperature looked like this upper curve does, to begin with.

Secondly, we have already, I think, recognized, and I am sure you have too, that these fish will get out of these areas if it gets hot and if there is a place to go. So the fact that we say that a lethal temperature is less then, lower than, an existing observed temperature doesn't mean that there aren't going to be sauger in the river at all. But as these dots approach--or maybe I should say it the other way around--as these mean temperatures approach these dots, then we ought to begin to see sauger disappearing or being reduced in number, whatever species it might be.

Again these dots over here--oh, those are the same ones that you saw before and they are based on the drop in temperature that they can tolerate.

The other point I should make about these overlays, one overlay really can't suffice for all zones in the river because the seasons change down here, so something like these winter lethal temperatures are going to have to be adjusted for the season. Maybe this dot ought to be erased as we go further south because obviously you are not going to have a cold temperature in that month like you have in the north, the season shifts. So this dot ought to be X'd out if you are going to use it on that particular station's data. It is maybe applicable in Minnesota, but it is not applicable in St. Louis.

Let's go to the next slide.

That will be what, Memphis?

MR. POWERS: Memphis, Tennessee.

DR. MOUNT: My understanding when I was working with Louisiana and Mississippi back in the early '60's, that down in that part of the river there are sauger in there but they are not very important and I don't think there are many, if any,

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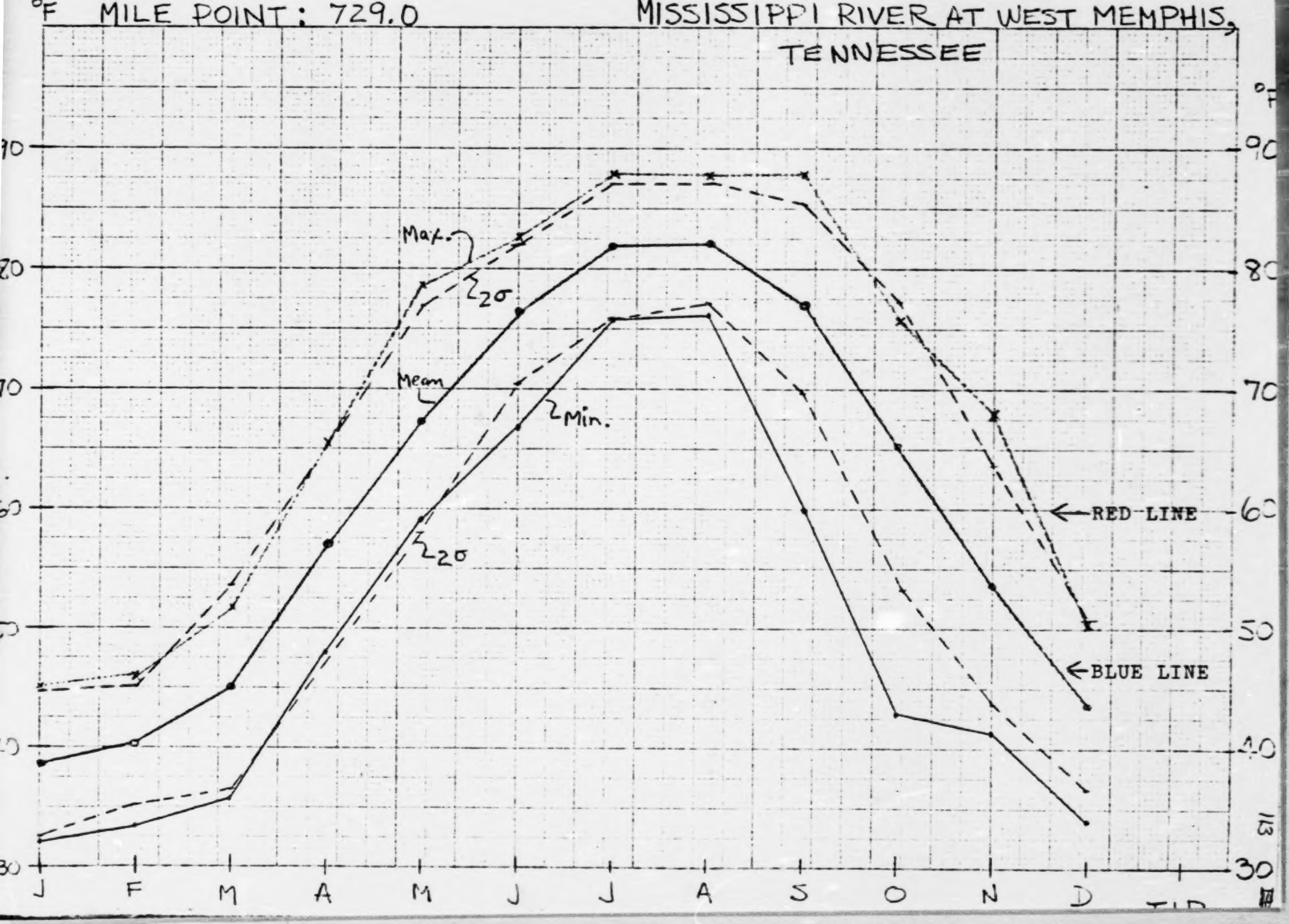
KEUFFEL & ESSER CO.

MILE POINT: 729.0

MISSISSIPPI RIVER AT WEST MEMPHIS,
TENNESSEE



northern pike. Is that a decent impression of what happens down there? Does anybody know?

MR. GRANTHAM: I think that is correct.

DR. MOUNT: Here there really isn't a great deal of difference in these maxes between this station and the one upstream, so I guess we have about the same picture as we had at East St. Louis. Sorry about that, Tom. Go to the next one.

MR. POWERS: Vicksburg, Mississippi.

DR. MOUNT: Is there one farther south?

MR. POWERS: Yes.

DR. MOUNT: Let's skip Vicksburg and go to the one south.

MR. POWERS: That is the furthest one south.

DR. MOUNT: Oh, furthest one south? O. K.

My comments right now, of course, are premised on the assumption that the dots are in the right place and that may not be an entirely correct assumption either. I am not suggesting that every dot is accurately placed on this thing.

But I think here we can see now that there has still not been a great deal of difference in these maximum temperatures, and if you look through this book that Tom passed out that you got you will find, I think, that the difference in maximum temperatures between Louisiana and Minnesota are not really all that great. They [illegible] a matter of a few degrees and the big

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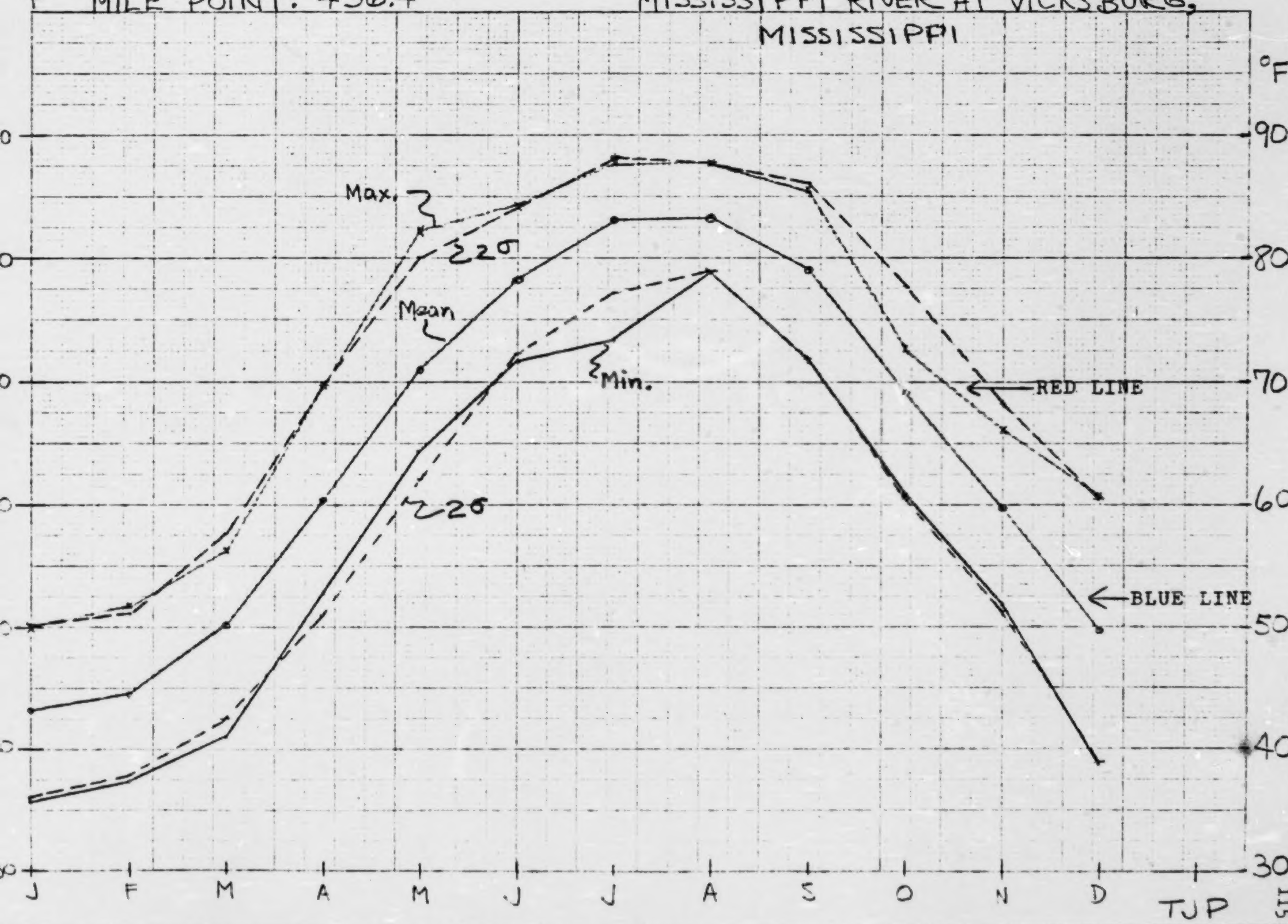
MILE POINT: 436.4 MISSISSIPPI RIVER AT VICKSBURG, MISSISSIPPI



difference is in the duration of these maxes and the means rather than their intensity. But we are seeing that this same level of temperature now is more nearly approaching the mean than it was upstream, suggesting again that this is getting out of the range of the sauger and I think this in fact holds with what we know about its range.

Tom, let's go next to the--

MR. STUBBLEFIELD: Don, before you go on, point out the catfish, identify those different species of fish.

DR. MOUNT: Oh. I am going to have to sneak up here.

The top row of dots are for bluegills and the second row of dots down are for channel catfish and the third row is for--well, you can look on your own overlays there and pick out what "S" is. It is "S" and largemouth bass. I am not sure what that "S" stands for.

MISS KEILHOLZ: Shad.

DR. MOUNT: Shad? And then the next row of dots is SB, which I believe is smallmouth bass, isn't it, and then fatheads are in here (indicating) and sauger are here (indicating).

Again let me mention that as you go further south you have got to erase some of these dots here because they were drawn in for a more northern latitude where the ambient temperatures would be down in this range during those months.

Now let's go to growth requirements.

MR. POWERS: Do you want to go to St. Paul first?

DR. MOUNT: Yes, let's go upriver to St. Paul and start back down again.

(See pages 106 and 118.)

Let's just pick three stations, top, bottom and one in the middle, to save time.

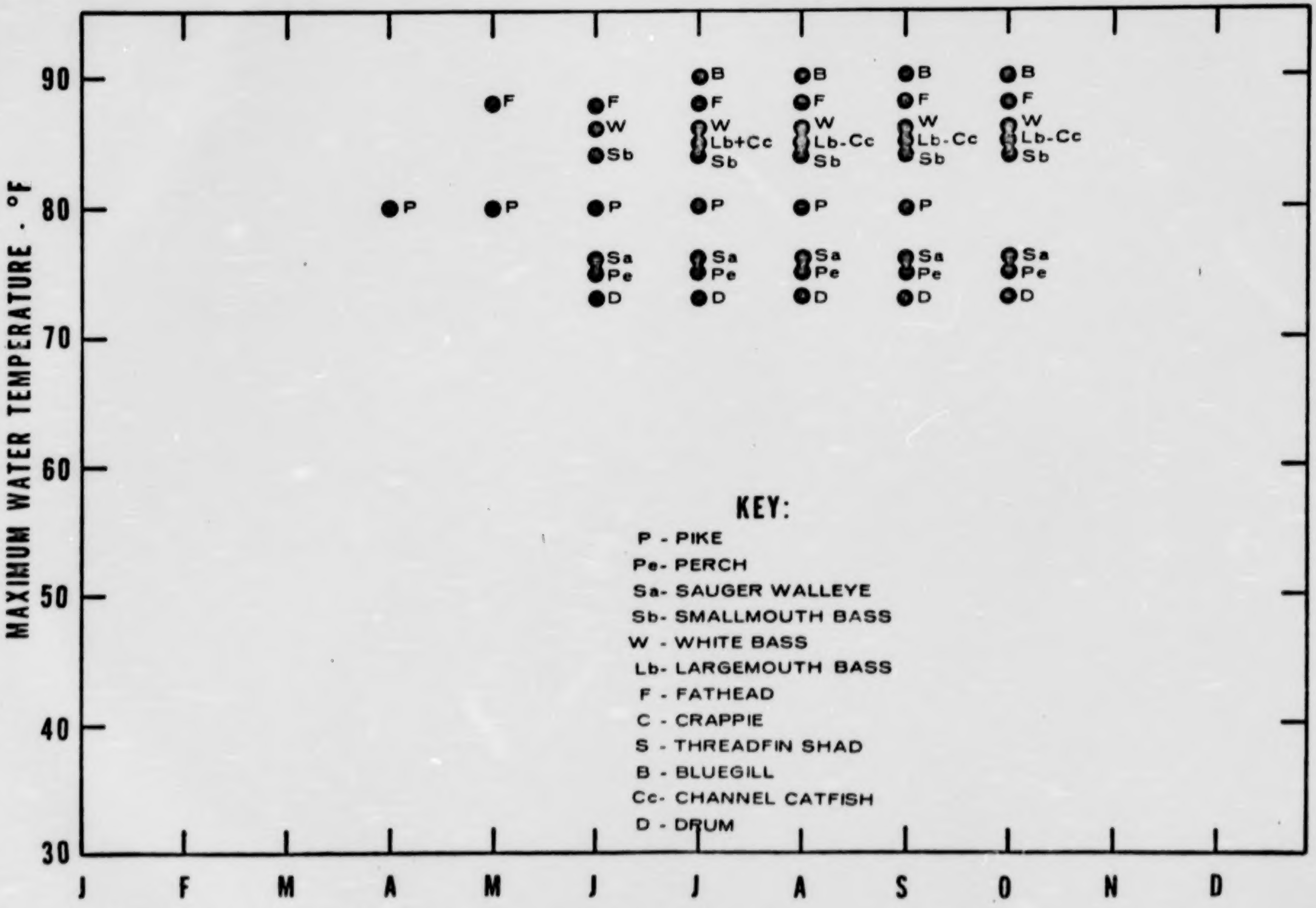
Before I even begin, let me say that this bottom row of dots is for drum and I think it is entirely wrong and I will tell you what it is based on in a minute and why we think it is wrong. So kind of forget that bottom row. There is only one piece of data on that that we know of right now, at least we had at the time this overlay was made.

Now, this overlay is a different one than we had before and this is what we believe are the maximum temperatures at which reasonably good growth can take place. Now, growth will take place at higher temperatures, but it is reduced. And so here we see that in the summertime that the mean temperatures are in this range, somewhere around 70 to 75, and also our dots say that these are good temperatures for sauger, perch and drum, and all three of these are important in the Mississippi River up in that area and they do fish for sauger a lot, it is a very desirable fish.

Here (indicating) is the gasper group, for those of

FIGURE 3

GROWTH REQUIREMENTS



who are from the south. And this (indicating) is a row of dots for northern pike. We find they are more tolerant to high temperatures than are the perch and sauger. But this fits what the river tells us, that these are good temperatures for these species and that is what our dots say, so the agreement is good here.

Let's go to a middle station, Tom.

MR. POWERS: Memphis, Tennessee?

DR. MOUNT: That would be fine, yes.

(See pages 113 and 118.)

This is again the same overlay for growth on top of the temperature records at Memphis, and the interpretation of this would be that this water is generally too warm for sauger and perch and it is probably getting to be marginal for northern pike but that it is O. K. for smallmouth and largemouth and white bass and fatheads and bluegills and this sort of thing. And I think again that pretty well fits the situation in the river.

So this to me lends considerable confidence that the numbers of the dots are reasonable, not that everyone is properly placed, but that we are in the right ball park and that these red dots do not in fact represent what are reasonable temperatures for these particular species of fish.

Let's go to one final one, the lowest one that you have. We have another overlay for reproductive requirements (see page 121), but I think we will not take time to go through that because the same kind of comments would apply. Although I could make this observation in making these comparisons, that it appears to me that it is not the reproductive period in this case that is limiting, it is more these growth requirements that seem to be limiting.

Yes?

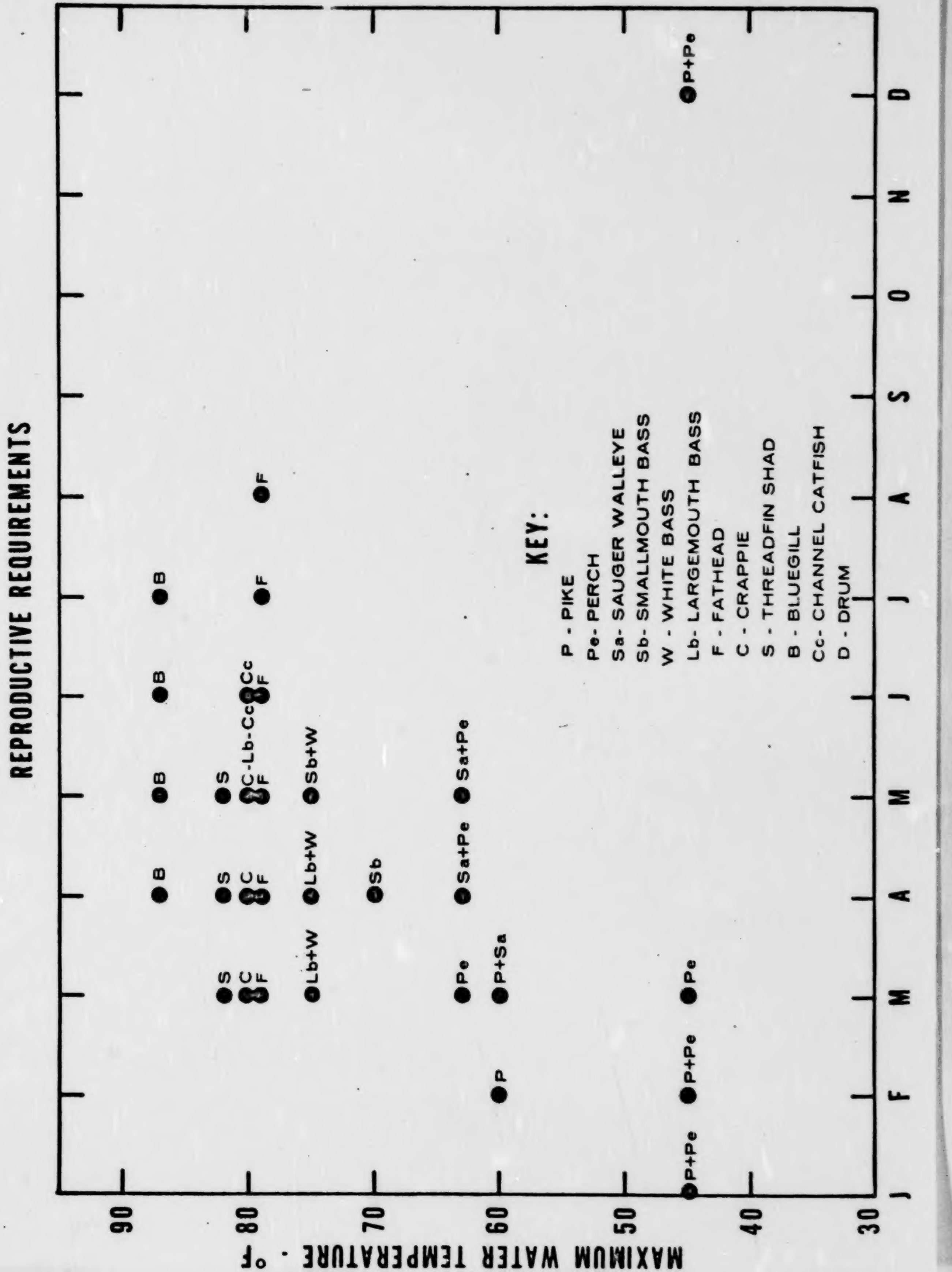
DR. MORRIS: When you talk about optimum growth, you are showing information on temperature here and I gather that your growth rate experiments have been determined in the laboratory. Aren't there other things that may be temperature associated in a river that would completely change the optimum growth rate? Aren't we hanging on to one peg here when there are several?

DR. MOUNT: Yes. Let me comment on that in just a minute because it is a good point and there are several things I would like to make on it.

(See pages 115 and 118.)

Just wrapping this up. This simply shows that farther south that the mean temperatures are way above the range for perch and sauger and this sort of thing and that you would not expect good populations, in some cases maybe no reasonable numbers, of these species in the lower reach of the river, and

FIGURE 2


REPRODUCTIVE REQUIREMENTS
MAXIMUM WATER TEMPERATURE · °F
90
80
70
60
50
40
30
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M
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J
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D
P+Pe
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P+Pe
S
C
F
Lb+W
Pe
P+Sa
Pe
B
S
C
F
Lb+W
Sb
Sa+Pe
B
S
C-Lb-Cc
F
Sb+W
Sa+Pe
B
Cc
F
B
F
F
P+Pe
KEY:
P - PIKE
Pe- PERCH
Sa- SAUGER WALLEYE
Sb- SMALLMOUTH BASS
W - WHITE BASS
Lb- LARGEMOUTH BASS
F - FATHEAD
C - CRAPPIE
S - THREADFIN SHAD
B - BLUEGILL
Cc- CHANNEL CATFISH
D - DRUM

again I think this pretty well fits the situation as it is known right now.

Well, so much for the overlays.

Let's see, we have got a couple of graphs that I would like to cover on the--

MR. POWERS: Daily fluctuations?

DR. MOUNT: Yes.

MR. POWERS: Here is April.

DR. MOUNT: I asked Tom to get together just a representative bit of data. This happens to be Red Wing, is it?

MR. POWERS: Yes.

DR. MOUNT: Yes, upper Minnesota again. It doesn't matter where it was taken from. But this is a plot of the daily maximum and minimum temperatures through the month of April. The point I would like to make is that if we apply the maximum permissible temperature for the month of April, it has to apply right here (indicating) as well as it does back down in here (indicating), and that if we have a given amount of heat input there are going to be these fluctuations in temperature due to climate and river flow and other things, so that we can expect variations in temperature even if we add more heat to the river, again a completely obvious statement.

But by putting maximums on the various months, we are in effect putting a lid on these peaks. In this case the lid

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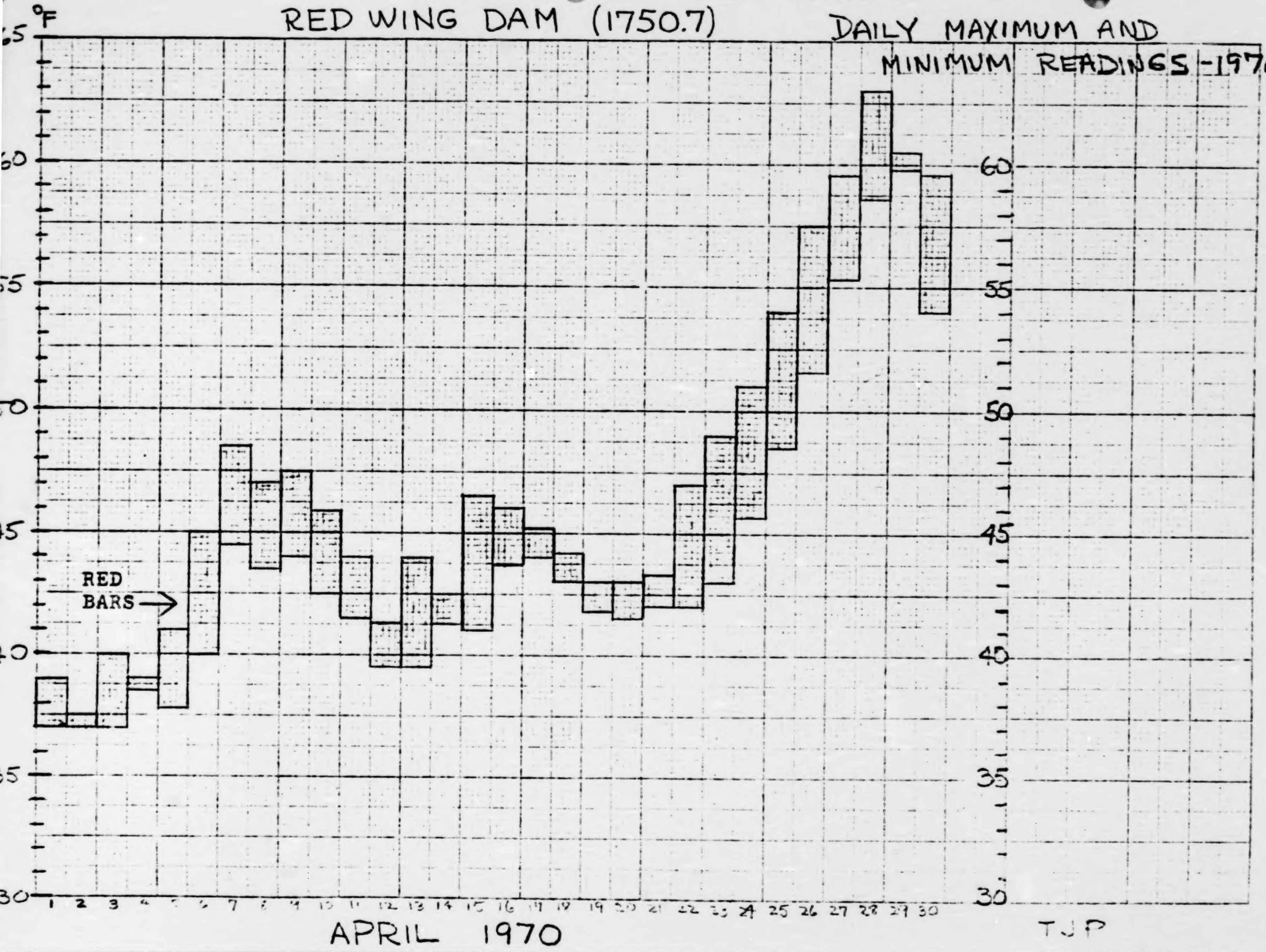
KEUFFEL & ESSER CO.

APRIL 1970
RED WING DAM
FWPCA MONITOR

RED WING DAM (1750.7) DAILY MAXIMUM AND MINIMUM READINGS-1970



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would only be applicable right in here (indicating). I think in our growth studies on perch and sauger that we feel that 65 is somewhere around the maximum temperature that ought to be permitted for the period when the fry are in the water. And this again is consistent with what the temperatures are up in that range.

But the point is that if we put a maximum we still must have these kinds of fluctuations. We can't turn a maximum into a mean or a constant temperature or we will not have suitable temperatures.

Let's look at May now and then we will stop with these overlays.

This is a month where the rate of warming is much slowed down and here we can see that a maximum temperature imposed is going to come closer to suppressing temperature on two days out of the month instead of just one. And, of course, as you would approach summer tempeatures of June, July and August, then, this bar graph or graph would be pretty much horizontal and you might have several points where the maximum existing temperature is approaching the maximum that you have imposed.

But again I would like to stress the need, if we are talking about maximums, this doesn't mean that we can tolerate those maximums continuously or that we can in fact greatly

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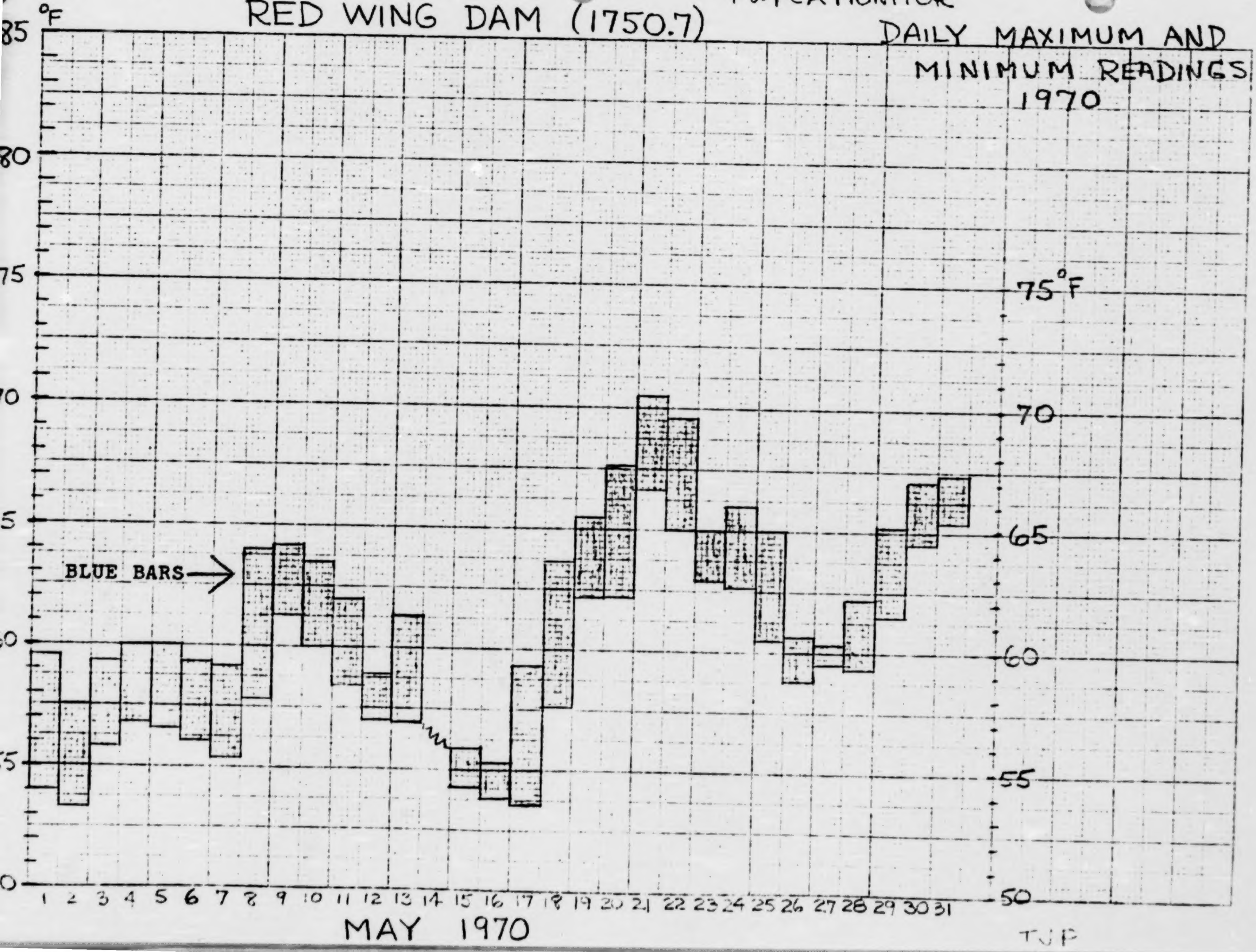

reduce this variation that goes on, because it is during these cooler periods that the fish are able to grow again and if the maximums are approaching the tolerable level.

O. K., I think that is good enough for the slides.

Now, in regard to this comment about optimum temperatures, and so on, this is, I guess, kind of a bad word to use because it conveys the wrong thing. In comparing lab data and field data we find that the agreement really is quite good if you use the data properly and take into consideration some of the reasons for variations that might exist.

For example, one of the measures of temperature selection that has been used is what they call a preferendum or the preferred temperature of the species, and they find that invariably in the field when they measure this that a given species will select a higher temperature than the laboratory studies have showed. Recent work that has been done indicates that the reason for this simply is that small fish select a warmer temperature than a large fish does, of the same species I mean, and most of the lab work has been done with these small fish. So there is a perfectly logical reason, therefore, why the lab data on temperature selections shows a slightly higher value than that in the field.

If any of you have not--well, I am sure many of you have not. Dr. Gammon in Indiana has been doing work for the

Indiana Power & Light, is it, or one of the power companies there, and he has just summarized a report from 1967 to 1969 in which this is all field data, he has been working around powerplants on the Wabash River and I guess another river, and he lists the species that he found below the plants, this is all on fish or almost all on fish, and the species found above plants and he groups these species in terms of their heat tolerance, highly heat tolerant and less so and cold preferring, and so on.

And one of his conclusions in here is that, No. 5, generally good correspondence was found between laboratory determinations of temperature preferenda of some resident species and their abundance, and so on. And he points this out in several places, that there are some cases where it doesn't agree, but on the whole that the agreement is good.

One of the, I think, important relationships that we have observed in looking through the literature is that there are three measures of temperature effect which seem to agree pretty well. They come out about the same. If we look at the temperature at which growth rate is best we find that it is about the same temperature as the temperature that fish select if they are given a choice. For example, in a lake where you have got stratification, if you find out where the fish are staying in the summer months and measure the temperature there, you find that this is pretty closely related to the temperatures that they grow best at and I think this is a logical evolutionary reason, you know.

Thirdly, if you look at the food conservation efficiency of these fish you find that that temperature pretty well corresponds with the temperature that they select and the temperature where they grow best. Again I think it all fits together.

So, therefore, in trying to put dots on charts like we have done here, we have used in many cases preferred temperatures where optimum food conservation takes place to get an idea of what a species requires if there is not good growth data. We are not saying that food conservation per se is a big deal, but it does lead us in the direction of what is an acceptable temperature for growth for that species of fish.

And here is where we got into trouble with the drum, because what we have learned is--what we suspect; we really aren't sure yet--but what we believe is that the drum is one case, and there are others, where they select a much lower temperature than where they grow best. The smallmouth bass appears to be another one that does this. It really likes temperatures in the high 70's, but it can take temperatures all the way up to 95 or so without getting into any real trouble, apparently. So this is why we think that the dots for the drum are really in the wrong place and should be changed.

I got together yesterday before I left some information and I have got, I think, 13 copies, Mr. Chairman. I really don't think they need to go into the record. There is a copy here if you want to. But I would like at least for each of the States to have a copy.

This is nothing that you want to sit down and read from cover to cover, but it is nothing but Xerox copies of raw data cards that we have got in our files. Much of it--practically all of it is out of the published literature, and its only purpose is to show you the kind of information that is available in the literature if you look. It is buried in hatchery reports, it is buried in the foreign literature, it is buried in physiology studies. YOu may only get one value out of a publication, but if you put all these together you get a coherent picture.

This is not by any means a complete data file that we have. It is simply we just pulled out some cards on different species of fish to show you the kind of data that is available and we have tried in some cases to underline the temperature data that happens to be in that reference. Some of the references are the most unlikely places in the world to look for temperature data, but you find it there if you look.

And frankly, I am getting a little bit tired of hearing everybody saying we don't know anything about the effects of temperature on aquatic life. If you haven't looked, of course you don't. But there is a lot of information in the literature and to be sure a lot of it is piecemeal and some of it isn't any good, but the point is that if you really sit down and dig you can find a lot of information about some of the common species that we are concerned about. You don't find it in a dictionary form. You don't just open the book to page 75 and read what is required for this species of fish, but if you put these things together they make sense.

So this gives you just an example or a sample, I should say, of the literature that we have gone through to find where these dots ought to go and we have quite a bit of research under way which we hope will fill in some of the holes that have not been filled in before.

Well, I think I have probably talked too long, so I am going to shut up now.

MR. STEIN: Are there any questions on this?

MR. HARRISON: I might make a comment. I am sure that Dr. Mount is trying to make a point that will come up later, and if I read his testimony or his statements, I think they lean pretty heavily toward establishing the point that distribution is dependent upon temperature. I think we ought to realize that there are a lot of things that determine the distribution of any species of animal besides temperature. We have temperatures here in the Midwest that might support elephant growth. We don't have any elephants nor do we want them.

So I throw that out for what it is worth. There is much more to this than temperature. When he pointed at the smallmouth bass range, I am sure that it isn't just temperature that determines its distribution because it is limited east to west as well as north to south and if it were temperature it ought to go across the United States east to west.

MR. STEIN: Do you want to comment on that now? Here is what I think in a sense we are looking for and I ask the biologists to do this.

By the way, I think, hopefully, I am speaking for the administrators too, because here is the problem that we are facing.

Recognizing what you say is so, Mr. Harrison, the problem that we have, if we are talking in terms of a regulatory tool, we are dealing with here really two concepts on temperature control. One, I think we fairly well came to an agreement last time that we are not going to allow temperature of more than 5 degrees.

MR. HARRISON: That is right.

MR. STEIN: The other question, and what I hope this would get to, whether we reasonably can expect to put maxima in for various months and, as Don Mount pointed out, put a cap on this for various months during the year. The reason I say that, and I know Dr. Mount has made this point with us many times, that just giving a temperature rise is not enough. For example, if you have tributaries and if you have streams and if you have drought periods and if you have other conditions, if you permit a 5-degree rise and you have water of 80 degrees and the cutoff point is going to be 82, above that you may get lethal effects, and if we permit the 5-degree rise and go up to 85 from 80, we may wipe out a considerable portion of the fish or if we get it during a spawning season or something they will not be able to spawn.

The question I think that we are really asking is this: Is it reasonable in addition to that 5-degree rise to put another limitation on this month by month and is it reasonable to divide the river into zones in order to do this on the basis of what they simplified this to five zones? These are the administrative questions that we have.

In dealing with any of the regulatory factors that we have, we recognize that any of these don't by themselves create a species. In a way we have kind of got a slow motion or worse than slow motion, we stop the film altogether and you are looking at a particular slide to try to put something up, and I know that temperature or any other factor, oxygen maybe, salt, whatever you have, lead or phenols, you name it, it is not by itself going to be the single contributing factor, except in specialized cases, in aquatic growth. What we are looking for is if it is reasonable that the biologists can agree on a consensus so we can judge the powerplants that are going to come in.

I wonder if you would just give me a minute to give you a very practical situation. I think a lot of us came here last night not expecting what we found in another area of the country. Maybe we had better go off the record on this.

(Off the record.)

MR. STEIN: Let's go back on the record.

DR. MORRIS: I think Dr. Mount provided a lot of information that some of us were missing and needing. He brought out, as I heard, three significant points; a couple of them bother me. One of them was your comment that we are in a necessary enforcement situation, and I was intrigued with the statement he made about the fact that this was being based on temperatures in the river, not the waste discharge itself. I think we have to keep that clearly in mind. The last time we were talking about point measurement even in the discharge pipe and we are talking about temperatures. I think he very clearly stated that this was something that happened in the river because that is where the fish are.

This brings up the concept of mixing zone very definitely and I don't know whether it is in the record or not, but this is the point I was trying to get at when I tried to set forth a formula for judgment as to the importance of thermal discharges into a stream.

I wonder how much wisdom we will get into this when we talk about discharge into the river and whether it follows a shoreline, whether it stratifies at a certain depth. As he pointed out, fish have to live in this for a period of time, for 24 hours or more, in order to at least show some of the effects he has been discussing.

I think we have to keep this clearly in mind and the way we were discussing it at the last meeting indicated that we were beginning to get closer and closer and closer to the pipe. These temperatures that we have been measuring in the Mississippi River are point source temperatures and that isn't where the fish live and I think that is what he was bringing out here. I urge that we keep this clearly in mind.

MR. STEIN: Are there any comments?

DR. MORRIS: There was one point he did make which was on the opposite side of that, and I hadn't thought of this, it is a good point. If fish are attracted to these warm weather temperatures, even if they do have adequate space to escape, the temperature drop that he discussed is something different than I think a lot of us were thinking. This is important.

MR. STEIN: Are there any other comments?

Dr. Morris, I agree with you completely, and since our last meeting in trying to talk to a lot of the technical people here I almost despaired of making this concept go through. Sure, we agree with what Dr. Mount said and what you said. I think everyone agrees with this. And no one is arguing that what you are dealing with is the effect on the river.

The question here that we get back to again and again is if a guy is running a powerplant, how are you going to ask him to comply and what are you going to ask him to control? And again I don't want to belabor this because you are going to have to do this on a State-by-State basis if you don't want to do it here if you have this mixing zone, but it seems to me that that man who runs the powerplant is going to be controlling the volume and strength and possibly direction of the water that comes out of the pipe. You are going to have to make some kind of judgment when you issue him that permit that these conditions are going to happen in the stream, but that is going to have to be your judgment and the question of putting the regulation on the guy who is discharging would seem to me, as dealing with every discharger, it is in effect what goes on in that man's pipe, whether he is running an industrial plant, a municipal plant, or, if you want to make a third distinction, a powerplant, and obviously in all cases we are dealing with what happens in the stream. But I would not say that on a day-to-day operation that these guys check their effects in the stream. They may look at it from time to time; what they do is check their effluent.

Again I don't think there is any disagreement, Dr. Morris, and if this kind of stuff bothers you here, we will consider your mixing zone concept and what you want to do.

DR. MORRIS: My point is established.

MR. STEIN: Right. All right. I don't think there was ever any disagreement.

Are there any other questions?

DR. MOUNT: I have one question handed to me here. I think the essence of it asks, that if temperature is acceptable for a particular fish will it be acceptable for the organisms that the fish feed on.

I didn't show any of our work or any of the published work on either the plankton or the benthic organisms because as best we have been able to determine, to begin with there is no one organism which is required as a fish food. They are pretty much opportunists and will feed on what is available within zone limits, and that as you look at the range of tolerance or acceptability of temperatures for these food organisms, it is quite wide and in most cases goes well above the temperatures that are acceptable for the fish that we are concerned with.

And I think again, going back to the field and making an observation, that this is consistent with what has already evolved in that wherever fish are able to live in a temperature they seem to find adequate food to feed themselves.

So while there is some concern about getting temperature cycles out of phase with seasons, which could perhaps be more important than the actual temperatures that we have, I think other than that that we sort of feel that as best we can determine the food is not the primary link in this case as it might be with pesticides or something like that.

MR. STEIN: Are there any other comments?

MR. MULLICAN: I don't know whether this is the time to bring this in or not since we are discussing the Mississippi, but in our State the lowering of temperature affects large areas too, especially below tail waters, and if this is to be the example that the other inland streams will follow, then I think this will have to be considered also, especially below high rising dams, tail waters, et cetera.

MR. STEIN: Do you want to comment on that, Don?

DR. MOUNT: Well, I am not sure what I can say other than I agree, it is a concern where it happens and I think the growth curves that I showed you, one of those slides which had the three U-shaped curves on is a clear illustration of what happens if the temperature is either too high or too low, you don't get growth or you don't get spawning. And I don't know what the regulatory answer to this question is, but it is very clear that if you do put these big dams in and discharge cool water you are going to wipe out some of the species that are there and get some different ones.

MR. STEIN: Yes. Well, I think it is the same as raising the issue. Again I would agree with this from a regulatory operation. This is somewhat, I guess, analogous to putting fluorides in water for dental caries. If you don't have any you might get them; if you get too much you are going to get mottled teeth.

So you have to strike a balance. Too much or too little heat is a problem, and that is what I think we have to deal with the regulation. I think it might be unfortunate, but even as experts we find ourselves following the popular version of considering the question of temperature in stream and with the push of the powerplants the popular word now is thermal pollution. Thermal pollution always means a rise and people don't think of a fall or getting away from the optimum, but I guess that in the kind of operations we are in we have to think of both.

There is a way, since most temperatures, although perhaps by the dams, of the regulatory agencies are getting in their pitch on that, I think because there is a process where we put in our comments on what the effect of releases from impoundments are going to do in a particular river and this doesn't only refer to lowering the temperatures in some cases but putting out water that is devoid of oxygen. Many of the impoundments did before we got too smart, not only did the water come out cold but they took it from the hypolimnion and shot it out, no oxygen and much colder, and it really did some devastating work.

But I think the essential issue that we have to face here on the standards application is going to be the requests for big and larger powerplants. Really, as far as I see this, I don't think we face any more crisis on heating of water now from cities or other industries than we have had for the past 25 or so years that I have been in the business.

So really the administrative issue that we are all faced with is the kind of issue I told you about last night and the kind we are presumably going to face up in Chicago toward the end of this month of having one, two, five or six tremendous plants coming in or with applications that they are going to come in and start building and generating power, using a lot of water and discharging water, a lot of apprehension from the public on what this might do and everyone turning to us, both the public and the industry and everyone else, and asking us for a reasonable evaluation of what the requirements should be.

All these points that you make are very well taken, but administratively I think this is going to be a big problem.

DR. MOUNT: Mr. Chairman, I would like to make a request that if some of the States do feel that this is going to be a significant problem, this cold water release business, I would really like to know about it because we have stopped doing our research in a way that will get data on this end of the temperature spectrum simply because the costs are so high. It stretches these tests out to two or three times their normal duration and the equipment for chilling, and so on, is expensive. We just terminated that sort of work, even though we started out that way, but we are going to be caught with our pants down again if this is really a major problem, because I don't think there is hardly anything available on that kind of problem.

MR. MULLICAN: We have some on-site locations, if you could put your personnel there, that would probably give you the natural situation.

DR. MOUNT: Well, we can use our grant and contract group for something like that too.

MR. STEIN: Yes, Mr. Schliekelman.

MR. SCHLIEKELMAN: You mention the fact that you are concerned about some of the large powerplants coming in and being concerned about the effect of heat from those on our streams. However, you have been also talking about a 5-degree rise at the point of discharge. I don't think those two items are compatible.

Also at the present time we have had an industry in the eastern part of the State, Iowa, which made application for a change in discharge. What they want to do is discharge 1,400 gallons a minute of condenser water heated 10 degrees. This is about 3 CFS discharge into, say, maybe an average of 30,000 CFS total flow in the stream.

The Bureau of Sport Fisheries, Fish & Wildlife Service, has turned this application down, I don't know the exact reason but they have turned it down for this amount of heat addition. On the other hand, this same city, a city of about 30,000, is discharging during the winter months municipal sewage which has a temperature of 26 degrees higher than the 32-degree temperature of the Mississippi River. If this same 5-degree limitation is applied to the city they are also going to have to put in cooling towers or some kind of cooling capacity. At the same time the Fish & Wildlife people have not made any attempt to regulate the temperature of this particular municipality.

I think we are going to have this same thing occurring in all communities whether they take water from the rivers or whether they take ground water. If we are going to be controlling 1,400-gallon-a-minute flow of condenser water, I think all of our existing generating plants as well as industries are going to have to put in cooling towers. And as far as I know now, I don't believe there has been any definite indication that any adverse biological effect has been created.

The upper Mississippi River Conservation Committee has a number of studies going and I think their conclusion on that has been that from the existing powerplants there have been no detrimental effects created at the present time where they have been making the studies at the present time. But yet if we are going to be using the 5-degree limitation on discharge point, this actually means closed cycle cooling every place.

I don't think we are being consistent when we are talking about large powerplants and yet a small industry discharging 1,400 gallons a minute has been refused a permit to put in a new outlet into the Mississippi River. Maybe EPA doesn't feel this way, but maybe another arm of the Department of the Interior is going to be doing this.

MR. STEIN: We are not in the Department of the Interior any more.

MR. SCHLIEKELMAN: O. K. But the Department of the Interior will be taking this--

MR. STEIN: They are represented here if they want to answer.

Schlick, I appreciate your comments. You know, we go over this again and again and I don't want to belabor the point. I think Dr. Morris indicated, and I thought we indicated our agreement, we were not talking, and as far as I was concerned never talking, about this 5 degrees at the point of discharge and we are not talking about closed cycle systems for every industry and every municipality. I know these things come up and if you think that this is going to help a resolution of the problem, maybe it is worth discussing, but I do think again, let me give you the judgment that I have, we have to talk in terms of what Don Mount and Dr. Morris talked about in terms of effect on the streams. I think we have to also make a reasonable classification, as I pointed out many, many times before, of what kind of heated wastes we are going to regulate. I have not seen, and I think I have been around as many cases as any, that we have a problem of heat from most municipal and industrial dischargers.

You also have this problem, as you well know, in the winter months with the municipality that is not using a surface water supply and using a ground water supply or wells for its water supply that they may be taking in the water anywhere from 5 to 10 degrees, maybe you don't have this down south so much, higher than the river water. And obviously it is going to be warmer more than 5 degrees when they put it out of the sewage pipe because it comes in more than 5 degrees higher than the river water is on a cold day. I don't think we are talking about that. That has been going on.

Administratively we are trying to come up with requirements which are going to get at the problem we are dealing with, and I hope we are directing ourselves to that.

Yes.

DR. MORRIS: I can only hope that the wisdom that should come out of a group such as represented here on accepting the concept of the mixing zones will influence other agencies and groups to recognize the validity of this concept.

MR. STEIN: Are there any other comments or questions?

MR. HARRISON: One short question, if I may.

MR. STEIN: Yes.

MR. HARRISON: I would like to ask Dr. Mount, in their studies of this chill factor, has any thought or any controls on photoperiodism been worked into this?

DR. MOUNT: Yes, we have--well--

MR. HARRISON: You can answer it by yes or no, as far as I am concerned. If you have, why, that is one thing. If you haven't, that is something else.

DR. MOUNT: Well, there isn't a yes or no answer. The only answer I can give is that as near as we can determine from digging this stuff out of the literature that there are some species where photoperiod doesn't seem to make a darned bit of difference. There are other places where it seems it does control the spawning of the fish, so it isn't a clear answer. And we don't have a listing of which is which.

MR. HARRISON: Good.

MR. STEIN: Are there any other comments or questions before we go on?

MR. DICKSTEIN: Dr. Tarzwell, do you have any comments at this time?

DR. TARZWELL: We are behind time and I would say no.

MR. DICKSTEIN: I would like to ask Yates Barber to hold for a moment and pass on to his representative Bob Sharp, who primarily identified the species in the upper Mississippi and did the report for the Bureau of Sport Fisheries.

Mr. Sharp.

ROBERT W. SHARP, ENVIRONMENTAL ECOLOGIST
DIVISION OF FISHERIES SERVICES, BUREAU OF
SPORT FISHERIES & WILDLIFE, TWIN CITIES, MINNESOTA

MR. SHARP: Yes, thank you.

Mr. Stein, this material will cover much the same ground as reported by Dr. Mount, perhaps less quantitatively. It is derived from several major literature sources and will probably be old hat to most of the aquatic biologists present.

To read the entire statement would take probably 15 minutes or I could paraphrase it.

MR. STEIN: All right. Why don't you give us your statement, because I think what you and Dr. Mount say is going to be the dux of why we are here and I don't want to cut this off. I know, as Dr. Mount said, there are a lot of people here who aren't biologists and one of the reasons we are here--as a matter of fact, I think this is just the way it works out, but probably most of the people who are going to have the responsibility for making the administrative decisions are not biologists and the reason we came here is to listen to the biologists.

So you go on with your statement, Mr. Sharp. We recognize this isn't a novel and if something is repetitious maybe we have to hear it at least twice before we understand it.

MR. SHARP: Very well. On that basis I will proceed.

The characteristics of the fishery.

The varied aquatic habitats associated with the Upper Mississippi River support one of the richest fish faunas in North America, with some 122 separate species being found in the 800-odd miles of river above the mouth of the Ohio River. At least 35 species enter the sport catch, with about 10 species making up the bulk of the creels. These are, in the order of importance:

R. W. Sharp

1. Bluegill
2. Freshwater drum, or Sheepshead, as most anglers call it.
3. Sauger
4. Two species of crappie, the black and the white.
5. White bass
6. Walleye
7. Carp
8. Northern pike
9. Channel catfish
10. Yellow perch

This reach of the Mississippi River ranks as one of the leading sport fishing areas of mid-America and supports an estimated three million man-days of recreational fishing annually.

This same reach of the river supports a commercial fishery based on approximately 15 species with the dominant ones being carp, buffalo fishes, freshwater drum and catfishes. Between the years 1953 and 1964, the catch averaged 10,300,000 pounds, in round numbers, per annum at an average annual value of $1,135,000. Some decline is now apparent in the number of fishermen participating,mainly because of economic factors.

Temperature factors. Since temperature criteria are the main issue at this hearing, several factors should be considered in this connection.

R. W. Sharp

Temperature is probably the most important but least discussed parameter in determining water quality; a stream or lake may thrive or die because of water temperature factors.

The rapidly expanding use of streams for domestic and industrial purposes is artificially warming the surface waters of the United States. The mean annual temperature of the Mississippi River at St. Paul rose 3° from 1923 to 1962, the readings being 51° in 1923 and 54° in 1962. This change occurred in the face of a 4° drop in mean air temperature over this period.

The water temperature is a critical factor in the life of fish and other water organisms and consequently in fish production. It affects to a considerable degree respiration, growth, and reproduction of fish.

Each species has a thermal tolerance zone in which it behaves in a normal manner; also there is a zone of higher temperature and one of lower temperature in which the species can survive for a certain length of time. A gradual and regular acclimatization allows certain species to survive in temperatures that would be fatal if they occurred suddenly. Fish adapt themselves quickly to a rise in temperature, but less easily to a drop in temperature.

A distinction must be made between tolerable environmental conditions determined experimentally in the laboratory and those conditions under which fish can be expected to occur and thrive in nature. Their ability merely to survive under unnatural experimental conditions requiring no sustained activity obviously is not a reliable indication that the quality of the medium is satisfactory. The optimum temperature for activity of a species does not necessarily bear any relation to its lethal temperature. Temperature extremes or sudden changes are often lethal. Elevated sublethal temperatures may induce estivation and a depressed one, hibernation.

The growth rate normally increases with temperature to a maximum and then decreases, perhaps becoming negative at temperatures approaching the lethal level.

In general, the upper limits are more quickly critical than the lower limits, despite the fact that many organisms appear to function more efficiently toward the upper limits of their tolerance ranges.

We have some listing of the so-called preferred temperatures and these have, of course, an important bearing on fish distribution. I will list a few of the more commonly occurring species of the river.

The bluegill at the top of the range is 90.2, the largemouth bass 86 to 89.6, the carp 89.6, the goldfish 82.6, smallmouth bass 82.4, the yellow perch 75.6, the fathead minnow 74.0.

R. W. Sharp

It is generally accepted that fish are sensitive to temperature, can recognize a change as little as half a degree Centigrade, and readily select preferred temperature.

The preferred temperature and temperature for optimum activity and growth in warmwater species of interest are, for the most part, considerably below the 93 degree range figure which was originally recommended in many water quality standards. Although probably not lethal to most warmwater species, a temperature of 93°F. if maintained for a long period, would probably reduce activity and growth and ultimately be detrimental to many of the warmwater species.

A 93° upper temperature limit is considered unacceptably high for most fish life. This upper limit, being above the median tolerance limit for many aquatic organisms, does not begin to consider the synergistic effects of temperature and other pollutant conditions which might be present in given situations. The fact that 90°F. may be approached and/or exceeded under natural conditions does not justify allowing thermal wastes to duplicate or aggravate an unhealthy aquatic condition.

Equally important, from the aquatic life standpoint, is the fact that any single upper temperature limit (even one lower than 90°) represents a very unsatisfactory solution to the problem of establishing temperature standards. Such a single upper limit does not take into consideration normal, subtle aquatic life patterns, which involve gradual warming periods, temperature plateaus, et cetera. In other words, an upper limit that would be perfectly satisfactory in July or August would represent a wide-open license for thermal pollution during the rest of the year.

The effects of temperature on reproduction of fishes.

Many temperate zone fishes take their seasonal cues for specific behavioral sequences from the length of the daily photoperiod acting in conjunction with the temperature. In addition to maximum temperature in summer, many water quality standards also state a limit on winter maximum or a maximum rise above natural. While the evidence is limited, low temperatures do appear necessary, in some species at least, for normal development of the germ cells. Available evidence suggests that winter temperatures should not rise above 60°.

The winter maximum is apparently the most critical temperature and must be sufficiently low to permit gonad maturation. While specific data are lacking, winter tolerance limits for game fish species apparently do exist.

A bit of material on egg temperature tolerances of some of the common warmwater fishes. I will read these very quickly.

The walleye, optimum listed at 62 to 67 degrees, with full larval mortality at 75 degrees.

Northern pike, optimum hatching temperature 54 to 56 degrees.

The smallmouth bass, no hatch above 80 degrees Fahrenheit.

Largemouth bass, complete egg mortality at 90 degrees.

Northern pike,complete mortality at 72 degrees with best survival at 60.5.

White bass, normal hatch at 60 degrees.

Yellow bass, spawn and hatch at 60 to 70 degrees.

And the channel catfish, optimum spawning temperature, 80 degrees.

There are a great many more here, but I think that will suffice to make the point without reading them all at this time.

The tolerance of the Centrarchid fishes (sunfish group) is apparent; the Cyprinids (minnows) less tolerant; with the catfish group somewhere in between.

In the rivers of England, fish populations, including rough fish, were reduced when temperatures reached 86°, supporting observations in this country that this temperature is close to the incipient lethal level for many warmwater fish and their associated biota.

There are four indices that determine the tolerance

R. W. Sharp

of a species to raised temperatures:

1. The upper lethal temperature for adults.

2. The temperature range that will allow satisfactory growth to maturity and spawning.

3. The temperature range for satisfactory development of eggs and fry.

4. Temperatures that permit normal development of the associated fish food organisms.

We should touch briefly, I think, on the matter of heat barriers that are likely to occur in major streams such as the Mississippi.

Migratory species may be halted by an unfavorable temperature barrier in a stream, a possible factor in walleye and sauger management, a notably migratory fish.

Thermal death of fish is not believed to be significant ecologically. Except in unusual cases of rapid temperature rise, gradual increases apparently result in avoidance of lethal temperatures by fish. The effect of temperature on growth, development, and activity is usually more significant because if the sublethal temperature is too high for the fish to successfully reproduce, be active and grow, the ultimate failure of the population is as decisive as a lethal temperature.

The effects of temperature on fish food organisms.

R. W. Sharp

There is some evidence that plankton production, the basis for most fish food, may be disrupted or altered in normal cycle by higher than normal late winter, spring, or early summer water temperatures. Low winter temperatures are apparently necessary to complete the resting stage of autumn Daphnia eggs; thus species composition of zoo plankton may change under conditions of higher winter temperature.

Bottom fauna organisms, another major component of fish food, may suffer from unusually high temperatures. Trembly's 1960 work in Pennsylvania indicated that 90° was a maximum tolerance limit at which a normal population structure of riffle macro-invertebrates could be maintained. An extensive loss in numbers, diversity, and biomass occurred at temperatures greater than 90°.

Insects in deeper water cannot emerge through heated surface waters in most cases, and snails and other animals that must come to the surface to breathe are either eliminated or have their life history interrupted.

Research results to date suggest that species of fish food organisms, in general, are less tolerant of high temperatures than most species of fish.

And a brief statement on disease and parasitism at higher temperatures.

Evidence would suggest that disease and parasitism of fish may be important at higher temperatures, but data on the subject remains scattered and inconclusive at the present time.

Mr. Chairman, that concludes our statement.

MR. STEIN: Are there any comments or questions?

Let me ask you one. Does the Fish and Wildlife Service or do you people have any opinion on why the mean temperature of the Mississippi River went up since the '20's while the general air temperature went down?

MR. SHARP: I think it might be reasonable to conclude, Mr. Stein, that this is a result of accumulated additions of heated effluent somewhere in the upper reach of the river in the vicinity of the Twin Cities.

Yes, sir.

MR. SCHLIEKELMAN: Where was that particular point of measurement on the river?

MR. SHARP: I think it was at a USGS station just below the Twin Cities, as I recall. I don't have the citations here before me.

MR. BRYSON: If this is the main station the USGS uses, this is about a quarter of a mile or half a mile downstream from a powerplant.

MR. DICKSTEIN: When did the powerplant go in?

MR. BRYSON: This is the Robert Street gauge station and this is where the USGS--

MR. STEIN: This is since the 1920's, though, is what I am getting at I noted that as another point, and I make no comment on this now, but if this in fact is the case and we are dealing with a 4-degree rise from 1920 while air temperature and climate has gone down, and if in fact you can project that kind of creepup in a significant stretch of the Mississippi to heated discharges, I think this is pretty significant. I don't know, I just put this out because this is the kind of thing that I think we have to watch.

Are there any other comments or questions?

MR. WHITLEY: We feel that the temperature all over in most Missouri water has raised in the last 50 years due primarily to tree cutting, stream channelization and exposure to heat, as Dr. Mount demonstrated here quite graphically, and the fact that these fish have evolved at quite lower temperatures than what we now call natural is a very important thing to keep in mind when we are adding any heat at all to the water. So various--

MR. HARRISON: I would comment on that, too, if I may.

MR. STEIN: Pardon. Let him finish.

MR. HARRISON: Excuse me, I thought he was through.

MR. WHITLEY: So a very small increase in temperature, some powerplants or any source, could conceivably raise these up to the lethal temperature or at least temperatures where species can't survive.

MR. STEIN: Mr. Harrison.

MR. HARRISON: Species of animals have been in the process of evolution for a long, long time, and I think that in the case of fish where there are so many of them reproduced that most certainly natural selection would take care of any 2- or 3-degree rise in water temperatures over 50 years. I can't believe that that would even be significant.

MR. WHITLEY: We have had examples of rather large mortalities due to what we call normal natural temperatures, so this can happen on a rather large scale.

MR. STEIN: By the way, I am making no judgment on this, but I think again if I listened to this correctly, there are several views on this and whatever the source, if you have land clearing and that is what has caused the temperature to go up and this is a phenomenon where the temperatures have gone up, this may raise the question of the stringency of allowing any more manmade source of temperature. This is the question.

I do know in some of the experience that I have personally had where, at least if your theory is, that they evolved under different conditions in an evolutionary sense and they have adapted. In some of the alewife problems we have had on Lake Michigan where the fish evolved with another habitat and came in there, they seemed rather fragile to me and I know biologists had a never-ending argument of why all those alewives died, but I had to deal with the stink and the mess and the cleanup and the flies.

This is a factor that you really have to consider, because it seems to me if these fish that we have in the river evolved under particular evolutionary conditions and we have changed these conditions, maybe they have adapted, maybe they haven't, but I think it is a judgment for the biologists to come to, and if you feel that they haven't adapted and they are a little shaky, then that may point in the direction of a more stringent temperature control wherever we can control another rise in temperature.

MR. HARRISON: I think we have seen this evolution in insects very dramatically. They have been able in a very short time, a matter of less than 10 years, to adapt to DDT and other chemicals, have to constantly change the chemicals to combat the insects. I can't believe that they can't adjust themselves to temperature, they have been adjusting themselves to temperature ever since they were here, when we can throw a manmade chemical into the environment, something that they have never had to adjust to, and they make the adjustment in a decade or two. Egh!

MR. STEIN: Well, I think we have the points of view.

Yes, Dr. Tarzwell.

DR. TARZWELL: If this assumption that you have made is true, the smallmouth bass would be down in the mouth of the Mississippi, because they have had many years to adjust to increased temperatures, and we wouldn't have variations in different parts of the country with certain organisms in certain areas because they could all adjust and they would go all down and we would find--

MR. HARRISON: I didn't say this.

DR. TARZWELL: --the sauger down in Florida, and so forth.

MR. HARRISON: I don't think temperature is that important.

DR. TARZWELL: Pardon?

MR. HARRISON: I say I don't think temperature is the overall factor. There are too many other things get into this thing.

DR. TARZWELL: But if they could adjust we wouldn't have different variations in different areas. They don't do it. And a very good illustration is the disappearance of trout from many areas after the logging, and there is a certain amount of adaptation, but if it is as great as you think it might be we wouldn't find this variation in organisms in different parts of the country.

MR. STEIN: Are there any other comments?

I wish I could heat you biologists up at other periods than just before lunch. (Laughter.)

Let's call on Mr. Rainwater now.

FRANK H. RAINWATER, CHIEF
NATIONAL THERMAL POLLUTION RESEARCH PROGRAM
PACIFIC NORTHWEST WATER LABORATORY, CORVALLIS, OREGON

MR. RAINWATER: I will keep my comments very brief and limited strictly to the engineers aspects here. I don't know what kind of maximum figures this group is going to come up with as standards, but I don't think that there is any significant engineering problem in achieving these standards whatever form they might take. We have now in use in the country, certainly, the mechanical draft towers, natural draft towers, cooling ponds, spray canals, these types of things, that are all applicable throughout this Mississippi River valley.

We heard some question about some of these devices in respect to fog formation or icing of highways and that sort of thing. In this respect, again, the Missouri River valley has an extremely low probability of any problems in this regard.

That is about all the comment that I wanted to make. We do have two engineering analyses that have been made by members of our regional office, one Mr. Wicks and another Mr. Zar here. If we have time, Murray, can we have that information presented?

MR. STEIN: Surely. How long will that take?

MR. RAINWATER: Arlie, what will it take?

MR. STEIN: How long are you going to take, Arlie?

MR. WICKS: I wouldn't read every number, but it will probably take 15 minutes.

MR. STEIN: And you?

MR. ZAR: I hadn't even planned to present mine.

MR. STEIN: The problem I am going to have is if I hold these guys a little longer they are going to really delay their lunch because people will begin coming in about this time and the place is going to get crowded. So if that is the case--

MR. PORTER: You've blown it, Murray, already.

DR. MORRIS: Let's finish it and go to lunch late.

MR. STEIN: Go ahead, then.

(Mr. Wicks' complete report follows:)

5°F River Temperature Rise
(Cooling Water - River Flows)

I. Power Plants - Cooling Water

Cooling water volumes and temperature rises vary with plant size and design. The nuclear plants are less efficient and discharge more heat per unit power than fossil fueled plants.

II. River Flows Required to Limit the River Temperature Rise to 5°F.

Assume: 1000 MW nuclear and fossil fuel plants have 1000 cfs and 750 cfs cooling water flows and temperature rises of 22°F. and 18°F. respectively. These are rough approximations. For better estimates of heat discharges data should be obtained on each plant.

	Nuclear and Fossil Fuel Power Plants (Approximate Values)					
	Nuclear Plant			Fossil Fuel Plant		
	Cooling Water		River Flows Required to limit River temp. rise to 5°F (cfs)	Cooling Water		River Flows Required to limit River temp. rise to 5°F (cfs)
Loading MW	Flow (cfs)	Temp. Rise (°F)		Flow (cfs)	Temp. Rise (°F)	
500	500	22	2200	375	18	1350
1000	1000	22	4400	750	18	2700

A. T. Wicks
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LOW FLOWS - EACH MONTH (Tem

MISSISSIPPI RIV

	Year	Jan.	Feb.	Mar.	Apr.	May	June
5-3895 McGregor, Iowa	1960						
Mississippi River D.A. -- 67,500 Sq. Mi.	1961	10,700	10,600	15,900	32,900	34,000	17,200
Avg. Discharge - 32,310 cfs	1962	11,700	12,000	14,100	73,300	48,900	34,100
(31 yrs. record)	1963	12,000	12,000	13,000	29,400	28,000	25,600
Mile Point 1587.4	1964	11,800	11,800	11,500	14,900	42,400	16,400
	1965	11,900	11,300	16,100	23,100	84,300	48,600
	1966	17,000	20,000	36,000	71,900	47,500	23,400
(Low Monthly Flow)	1967	14,800	18,400	18,000	67,500	26,300	15,200
River Temperature Rise °F	1968	10,400	10,300	12,200	21,700	23,700	38,100
	1969	22,000	25,000	27,000	75,000	50,400	28,300
(22,000 cfs = 1° F Rise) 1000 MW Nuclear		2.1° F	2.1	1.9	1.5	0.9	1.5
(13,500 cfs = 1° F Rise) 1000 MW Fossil		1.3° F	1.3	1.2	0.9	0.6	0.9

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						12,000	16,500	10,700
32,900	34,000	17,200	9,660	9,500	9,560	12,500	14,300	6,700
73,300	48,900	34,100	28,800	20,700	22,300	17,500	17,800	12,500
29,400	28,000	25,600	12,900	13,600	11,100	11,700	11,100	10,700
14,900	42,400	16,400	8,000	7,220	17,400	12,700	13,000	10,000
23,100	84,300	48,600	20,700	14,300	15,900	35,400	21,600	25,400
71,900	47,500	23,400	15,100	14,300	14,000	12,500	16,500	11,700
67,500	26,300	15,200	17,200	11,800	9,400	10,600	10,400	9,900
21,700	23,700	38,100	48,300	14,800	17,700	36,800	32,700	16,000
75,000	50,400	28,300	21,300	10,800	12,300			
1.5	0.9	1.5	2.8	3.1	2.3	2.1	2.1	3.3
0.9	0.6	0.9	1.7	1.9	1.4	1.3	1.3	2.0

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LOW FLOWS - EACH MONTH (

MISSISSIPPI

	Year	Jan.	Feb.	Mar.	Apr.	May	June
5-4205 Clinton, Iowa	1960						
Mississippi River D.A. -- 85,600 Sq. Mi.	1961	15,800	15,000	30,500	52,100	42,700	24,400
Avg. Discharge - 45,320 cfs	1962	17,100	18,100	20,200	101,000	72,800	50,100
Mile Point 1471.7	1963	17,000	17,500	20,500	41,600	44,100	35,400
	1964	15,000	15,400	15,700	20,500	52,800	21,200
	1965	17,000	15,400	28,000	60,800	107,000	63,800
	1966	20,000	26,500	54,200	81,500	59,100	32,800
(Low Monthly Flow)	1967	16,700	23,300	23,400	90,300	38,100	25,500
River Temperature Rise °F	1968	16,800	18,000	18,000	31,200	20,000	46,500
	1969	27,000	35,000	40,000	83,900	65,000	35,300
(22,000 cfs = 1° F Rise) 1000 MW Nuclear		1.5° F	1.5	1.4	1.1	1.1	1.0
(13,500 cfs = 1° F Rise) 1000 MW Fossil		0.9° F	0.9	0.9	0.7	0.7	0.6

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							21,800	27,000	19,200
0,500	52,100	42,700	24,400	16,500	15,100	17,600	26,000	33,400	16,500
0,200	101,000	72,800	50,100	42,000	28,600	36,500	27,400	26,500	17,800
0,500	41,600	44,100	35,400	16,300	19,900	17,700	15,900	16,500	15,900
5,700	20,500	52,800	21,200	14,100	10,900	17,500	17,600	19,000	16,000
8,000	60,800	107,000	63,800	26,200	21,900	28,000	47,300	37,000	31,000
4,200	81,500	59,100	32,800	22,000	21,000	19,000	18,700	22,700	16,000
3,400	90,300	38,100	25,500	26,100	19,800	18,300	18,500	20,000	16,800
8,000	31,200	20,000	46,500	63,200	23,000	23,100	44,700	40,800	20,000
0,000	83,900	65,000	35,300	38,300	17,800	19,400			
.4	1.1	1.1	1.0	1.6	2.0	1.3	1.4	1.3	1.4
.9	0.7	0.7	0.6	1.0	1.2	0.8	0.9	0.8	0.9

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LOW FLOWS - EACH MONTH

MISSISSIPP

	Year	Jan.	Feb.	Mar.	Apr.	May	June
5-4745	1960						
Keokuk, Iowa Mississippi River D.A. -- 119,000 Sq. Mi.	1961	21,800	23,200	57,100	71,500	58,100	30,3
Avg. Discharge - 61,060 cfs	1962	33,700	35,800	36,100	141,300	96,100	62,5
Mile Point 1318.0	1963	23,100	22,500	27,400	49,900	61,200	40,6
	1964	17,400	20,300	21,600	29,700	67,900	25,6
	1965	23,900	24,400	44,600	82,700	125,400	81,1
	1966	44,100	39,700	71,900	106,000	94,600	53,4
(Low Monthly Flow)	1967	25,100	31,700	31,900	129,000	48,700	29,7
River Temperature Rise °F	1968	21,400	21,000	22,100	37,800	43,000	63,5
	1969	36,700	49,900	58,000	130,000	92,500	60,1
(22,000 cfs = 1° F Rise) 1000 MW - Nuclear		1.3° F	1.1	1.0	0.7	0.5	0.9
(13,500 = 1° F Rise) 1000 MW - Fossil		0.8° F	0.7	0.6	0.5	0.3	0.5

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							21,500	38,800	24,0
57,100	71,500	58,100	30,300	19,200	19,600	16,200	41,700	72,900	27,6
36,100	141,300	96,100	62,500	47,200	35,500	42,300	37,000	33,000	20,7
27,400	49,900	61,200	40,600	21,300	23,700	18,100	18,400	19,000	18,5
21,600	29,700	67,900	25,600	16,100	9,800	19,100	17,300	21,500	15,6
44,600	82,700	125,400	81,100	26,000	22,100	42,400	68,500	51,500	53,3
71,900	106,000	94,600	53,400	37,900	29,100	18,900	19,700	24,000	18,0
31,900	129,000	48,700	29,700	30,400	22,200	18,800	20,800	31,000	21,4
22,100	37,800	43,000	63,500	73,300	27,000	27,900	50,900	48,600	23,6
58,000	130,000	92,500	60,100	101,000	22,400	26,900			
1.0	0.7	0.5	0.9	1.4	2.3	1.4	1.3	1.2	1.4
0.6	0.5	0.3	0.5	0.8	1.4	0.8	0.8	0.7	0.9

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LOW FLOWS - EACH MO

MISSISS

	Year	Jan.	Feb.	Mar.	Apr.	May	J
5-5875 Alton, Illinois	1960						
Mississippi River D.A. -- 171,500 Sq. Mi.	1961	31,800	26,800	69,900	100,000	113,000	119
Avg. Discharge - 93,130 cfs	1962	58,100	83,100	70,400	224,000	138,000	76
(39 yrs. record) 7.7 miles upstream	1963	24,400	23,400	28,700	72,900	79,600	49
from Missouri River	1964	21,500	24,500	29,900	48,900	102,000	35
Mile Point 1156.8	1965	26,000	39,300	62,400	150,000	166,000	99
	1966	51,300	50,300	102,000	148,000	153,000	63
(Low Monthly Flow)	1967	30,500	47,300	52,900	158,000	77,300	57
	1968	31,600	54,500	44,100	45,600	55,500	80
River Temperature Rise °F	1969	46,600	95,900	85,000	191,000	128,000	114
(22,000 cfs = 1° F Rise) 1000 MW - Nuclear		1.0° F	0.9	0.8	0.5	0.4	0.
(13,500 = 1° F Rise) 1000 MW - Fossil		0.6° F	0.6	0.5	0.3	0.2	0.

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

ar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							30,800	44,400	31,100
,900	100,000	113,000	119,000	31,100	142,000	28,200	57,000	117,000	53,000
,400	224,000	138,000	76,200	75,300	44,800	52,000	49,200	40,700	24,400
,700	72,900	79,600	49,400	37,300	27,800	21,300	24,400	24,400	19,200
,900	48,900	102,000	35,300	28,800	17,800	21,500	21,900	27,100	25,600
,400	150,000	166,000	99,900	41,600	35,100	65,100	91,100	64,600	79,400
,000	148,000	153,000	63,500	42,000	41,000	25,100	19,200	29,600	31,700
,900	158,000	77,300	57,400	57,700	26,900	26,800	24,800	49,000	53,500
,100	45,600	55,500	80,800	115,000	39,700	34,600	60,800	64,200	32,800
,000	191,000	128,000	114,000	162,000	51,200				
	0.5	0.4	0.6	0.8	1.2	1.0	1.1	0.9	1.1
	0.3	0.2	0.4	0.5	0.8	0.6	0.7	0.6	0.7

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LOW FLOWS - EACH M

MISSIS

	Year	Jan.	Feb.	Mar.	Apr.	May	
7-0100 St. Louis, Missouri	1960						
Mississippi River D.A. -- 701,000 Sq. Mi.	1961	49,000	49,000	112,000	209,000	248,000	10
Avg. Discharge - 174,000 cfs	1962	96,000	184,000	121,000	291,000	188,000	16
(105 yrs. record) 15 miles downstream	1963	35,800	46,000	60,000	114,000	132,000	11
from Missouri River R.M. 180.0 above	1964	35,800	46,600	46,600	87,100	150,000	10
Ohio River	1965	57,900	76,400	102,000	218,000	237,000	18
Mile Point 1133.3	1966	77,900	70,600	157,000	216,000	201,000	12
(Low Monthly Flow)	1967	44,700	74,200	77,900	211,000	133,000	16
River Temperature Rise °F	1968	67,700	93,500	84,000	118,000	112,000	13
	1969	91,900	157,000	152,000	316,000	243,000	20
(22,000 cfs = 1° F Rise) 1000 MW - Nuclear		0.6° F	0.5	0.5	0.3	0.2	0.
(13,500 = 1° F Rise) 1000 MW - Fossil		0.4° F	0.3	0.3	0.2	0.1	0.

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
							70,700	78,400	65,2
112,000	209,000	248,000	106,000	88,800	77,000	79,800	109,000	181,000	92,8
121,000	291,000	188,000	164,000	152,000	95,200	102,000	97,600	85,600	46,6
60,000	114,000	132,000	110,000	83,200	68,400	62,100	61,400	61,400	34,6
46,600	87,100	150,000	102,000	74,900	58,600	64,200	61,400	65,600	50,6
102,000	218,000	237,000	184,000	128,000	83,200	166,000	159,000	123,000	115,0
157,000	216,000	201,000	127,000	90,300	84,000	68,400	61,400	77,100	69,1
77,900	211,000	133,000	161,000	132,000	80,900	72,700	83,200	106,000	116,0
84,000	118,000	112,000	138,000	178,000	92,700	87,100	113,000	133,000	77,2
152,000	316,000	243,000	209,000	253,000	124,000	119,000			
0.5	0.3	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.6
0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.4

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LOW FLOWS - EACH MONTH (Te

MISSISSIPPI RI

	Year	Jan.	Feb.	Mar.	Apr.	May	June
7-0205 Chester, Illinois	1960						
Mississippi River D.A. -- 712,600 Sq. Mi.	1961	50,600	49,900	119,000	222,000	252,000	111,000
Avg. Discharge - 174,700 cfs	1962	105,000	209,000	140,000	302,000	193,000	175,000
(39 yrs. record) 8.1 miles downstream	1963	38,200	47,400	62,800	117,000	132,000	115,000
from Kaskaskia River R.M. 109.9 above	1964	37,600	48,100	47,400	91,000	149,000	107,000
Ohio River	1965	61,400	78,200	110,000	196,000	229,000	186,000
Mile Point 1063.3	1966	83,000	76,600	172,000	224,000	216,000	130,000
(Low Monthly Flow)	1967	48,100	75,800	79,000	210,000	138,000	152,000
River Temperature Rise °F	1968	75,800	101,000	87,800	134,000	118,000	142,000
	1969	95,500	170,000	152,000	316,000	258,000	218,000
(22,000 cfs = 1° F Rise) 1000 MW - Nuclear	...	0.6° F	0.5	0.5	0.2	0.2	0.2
(13,500 = 1° F Rise) 1000 MW - Fossil		0.4° F	0.3	0.3	0.1	0.1	0.1

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						71,600	85,200	66,800
22,000	252,000	111,000	94,500	78,000	82,800	115,000	154,000	99,000
02,000	193,000	175,000	157,000	96,400	104,000	100,000	87,800	48,800
17,000	132,000	115,000	85,400	72,600	66,300	62,100	64,200	38,200
91,000	149,000	107,000	81,400	60,700	66,300	64,200	66,300	53,000
96,000	229,000	186,000	138,000	85,400	168,000	163,000	126,000	116,000
24,000	216,000	130,000	92,800	87,000	73,400	64,200	75,800	72,600
10,000	138,000	152,000	136,000	82,200	75,800	83,000	106,000	113,000
34,000	118,000	142,000	175,000	105,000	89,400	114,000	143,000	82,200
16,000	258,000	218,000	270,000	127,000	127,000			
0.2	0.2	0.2	0.3	0.4	0.3	0.4	0.3	0.6
0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.4

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LOW FLOWS - EACH MONTH

MISSISSIPP

	Year	Jan.	Feb.	Mar.	Apr.	May	June
7-0220 Thebes, Illinois	1960						
Mississippi River D.A. -- 717,200 Sq. Mi.	1961	53,000	49,900	126,000	229,000	259,000	115,00
Avg. Discharge - 177,600 cfs	1962	110,000	236,000	161,000	314,000	199,000	191,00
(34 yrs. record) R.M. 43.7 above	1963	40,000	50,000	65,200	120,000	131,000	116,00
Ohio River	1964	39,800	52,200	50,600	93,000	154,000	107,00
Mile Point 997.5	1965	62,000	80,200	112,000	185,000	236,000	203,00
	1966	87,400	81,100	175,000	237,000	232,000	134,00
(Low Monthly Flow)	1967	52,900	80,600	86,300	215,000	148,000	149,00
River Temperature Rise °F	1968	75,700	109,000	91,400	147,000	127,000	145,00
	1969	101,000	180,000	158,000	334,000	275,000	226,00
(22,000 cfs = 1° F Rise) 1000 MW - Nuclear		0.6° F	0.4	0.4	0.2	0.2	0.2
(13,500 = 1° F Rise) 1000 MW - Fossil		0.3° F	0.3	0.3	0.1	0.1	0.1

LOW FLOWS - EACH MONTH (Temperature Rise)

MISSISSIPPI RIVER

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							75,000	84,800	68,500
0	229,000	259,000	115,000	98,500	83,600	83,700	115,000	136,000	109,000
0	314,000	199,000	191,000	163,000	95,500	104,000	104,000	91,000	55,700
0	120,000	131,000	116,000	89,700	78,000	69,200	64,800	65,700	40,500
0	93,000	154,000	107,000	82,900	62,400	70,400	65,700	66,100	54,500
0	185,000	236,000	203,000	157,000	89,100	145,000	168,000	130,000	117,000
0	237,000	232,000	134,000	98,200	92,900	77,600	65,700	77,600	83,300
0	215,000	148,000	149,000	139,000	85,400	77,000	83,400	114,000	117,000
0	147,000	127,000	145,000	183,000	111,000	90,100	113,000	154,000	89,100
0	334,000	275,000	226,000	308,000	131,000	127,000			
	0.2	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.5
	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3

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2/18/71

ARLEIN T. WICKS
WATER QUALITY STANDARDS COORDINATOR
EPA - WATER QUALITY OFFICE
KANSAS CITY, MISSOURI

MR. WICKS: Well, for different stations along the Mississippi River starting at McGregor, Iowa, and going downstream to about Thebes, we listed a low flow for each month for a period of 9 years and then based on this low flow we determined the temperature rise you would get assuming complete mixing with 1,000 megawatt nuclear plant and 1,000 megawatt fossil fuel plant.

Up at McGregor, starting with January and a nuclear plant, the temperature rise would be 2.1--

MR. STEIN: I am sorry, I don't understand you there. What do you mean by a temperature rise with complete mixing? If you mix it completely enough it is going to go back to what is natural. It depends how much you do it. I don't understand what that concept means.

MR. WICKS: It is figured on a BTU basis. If you took all the heat that was discharged and figured it on a BTU basis in the flow, it would raise the temperature of the whole river 2.1 degrees.

DR. MORRIS: For how far and how long?

MR. WICKS: Dr. Tarzwell, I think this is some of the things you discussed in the green book. I mean if you take the heat as discharged from a plant and you had complete mixing instantaneously, it would raise the temperature 2.1 degrees.

MR. STEIN: In other words, this is a theoretical concept, what you are talking about?

MR. WICKS: Right.

MR. STEIN: It doesn't happen.

MR. WICKS: You get a feel for how much heat--

MR. STEIN: It raises the whole river 2 degrees across the river and how far down?

MR. WICKS: You have--

MR. STEIN: Only just across that band where you are discharging?

MR. WICKS: See, with 1,000 megawatt nuclear plant, I am assuming 1,000 cubic feet per second cooling water with a 22-degree rise.

MR. STEIN: Now, here, don't--

MR. WICKS: And if you mix that with the river--

MR. STEIN: Here is the problem, and I think Dr. Morris raises it, I think--the reason I am raising this, if we don't get at this kind of concept here we are going to be in a lot of trouble. Now, I can understand, for example, if you take an inorganic like salt or phenols and you put it in, you are going to have a stage where you are going to be able to determine where it is completely mixed and it is going to roll on that way down to the Gulf more or less. You can even do that within terms with an organic because it is going to take the time to dissipate and we can set up a judgment. But if you are dealing with heat and heat keeps dissipating, you are not going to get a mix, you are going to get a loss, aren't you? And this is--

MR. WICKS: You are absolutely correct.

MR. STEIN: So I don't understand what you are doing. Is what you are talking about a complete mix, something that comes out of a pipe, how much will it raise the water temperature of the river flowing by that pipe at any particular point? Is that what you mean?

MR. WICKS: Right.

MR. STEIN: All right, I understand your concept, but now I have got the next point, I don't know how useful it is. But go ahead. What is the point?

MR. WICKS: It gives you a little bit of feel--

MR. STEIN: O. K.

MR. WICKS: --for the amount of heat that is going in there compared with the river flow.

MR. STEIN: All right, go ahead.

MR. WICKS: Well, I think I will just go through the months for McGregor, Iowa, and then towards the end so that we will get a little bit of a feel for it.

For a nuclear plant at McGregor, Iowa, January it would raise the temperature 2.1, February 2.1, March 1.9, April 1.5, May 0.9 of a degree, June 1.5, July 2.8, August 3.1, September 2.3, October 2.1, November 2.1, and December 3.3.

Now, by the time you get down to Thebes, Illinois, you have much greater flow in the Mississippi River. So for the same nuclear plant for the lowest daily flow for January for this 9-year period you would get 0.6 of a degree rise in January, in February it would be 0.4, March 0.4, April 0.2, May 0.2, June 0.2, July 0.3, August 0.4, September 0.3, October 0.3, November 0.3, and 0.5 degree in December.

This is just to get a little bit of a feel for the capacity--not the capacity, but the amount of heat going into the stream compared with the stream flows.

MR. STEIN: All right. Let me ask a question that will be meaningful, I think, at least to me.

Let me raise this. As I understand your technical point, Mr. Rainwater, is that you believe there are devices which could clearly be employed under the meteorological conditions in the Mississippi River valley which would reduce or be able to reduce the water to no more than a 5-degree rise after what they would consider reasonable mixing zone, right?

MR. RAINWATER: Correct.

MR. STEIN: All right. Now, let me get to the next--pardon. Let me ask my next question and then you can go on.

DR. MORRIS: All right.

MR. STEIN: The next point I would like to know, if we are coming up with these maxima as well as the 5-degree rise--right?--and there may be times, and I am not suggesting that they are going to come up to this, but there may be a maximum that these people put, say, for the month of May or say the month of July which is not going to permit a 5-degree rise because you are going to have the maximum that a particular degree of fish may--let me use my argument again. Let's suppose the natural at that point is 80 and they set a maximum of 82 and all you can do is raise it 2 degrees. How close can those systems work? Can they still produce a cooling which is going to let them put out, say, water for just a 2-degree rise?

MR. RAINWATER: I think we have to consider two systems here. One is a system that would be tacked onto the end of the pipe and treat all the flow as it went through and then discharge it right back into the river. Now, most of these systems are dependent primarily on wet blow temperature and under this situation there are a number of cases where this could not be achieved. On the other hand, if you don't use this helper system on the end there is always the possibility of going to the closed cycle system and from a closed cycle system all that you are concerned about as far as the river is concerned is a very, very small amount of water, the fraction that has to be blown down off of these towers, and anything reasonable in a mixing zone could take care of this.

MR. STEIN: Let me again do this. In other words, if I understand you correctly, the technology is here, but if we get down much below this 5 for some months, and this is up for your consideration, from an engineering standpoint the solution to this would have to be a closed cycle system at those points, say if we were down to 1 or 2 or 3 degrees instead of 5.

MR. RAINWATER: I would say so.

MR. STEIN: O. K.

Dr. Morris.

DR. MORRIS: My only comment was going to be, I think we all recognize the engineer can do anything if you provide him the money for it. The question becomes should we. And he has brought up again the mixing zone, which is the tail end on every one of these processes we are considering.

MR. STEIN: Again, Dr. Morris, I don't want to pursue this with you. There has been no argument from the beginning on the mixing zone. Obviously either you are going to--even if you have an essentially closed system with a blow down, sometimes you are going to have to let something come out of that system somewhere and there has got to be an area of mixing. So I don't think we are arguing this question of mixing zones.

Believe me, this whole situation here is what kind of requirement are you going to put on the plant operator? Are you going to make him responsible for what is coming out of the pipe or to have him police and be responsible for what is--

DR. MORRIS: The mixing zone wasn't the point of my comment. The point of my comment was, yes, it can be done, but the economics of it have to be considered.

MR. STEIN: That is correct. Now, sir, let me again ask Mr.--because we have been through this, and let me ask Mr. Rainwater.

Some of these powerplants have had to consider a closed cycle, is that correct?

MR. RAINWATER: We have them all over the country now.

MR. STEIN: Right, with closed cycle?

MR. RAINWATER: With closed cycle.

MR. STEIN: In terms of the economics what has this done to rates of the power companies? Have they been able to survive with this closed cycle?

MR. RAINWATER: They certainly have. I don't see any real correlation here with the rates, the rate structure, geographically, with whether or not they have been using closed cycles or not using closed cycles. Through the Great Plains area, most of the western area, it has all been closed cycle operation, the vast majority of them.

MR. STEIN: Again let me summarize this. I am saying this not just because of what we have heard here today, and if I am wrong on this I wish I would be corrected by the engineer. But the point is, what they say, either you are going to have to have cooling towers, cooling lagoons or spray, this is all on economics, but depending on which is cheapest, that the plants can afford these and possibly the most expensive system is a closed cycle system, but looking at the electric utility industry I think the judgment that at least our people have had is that this is an economically feasible alternative. It does not raise the rates inordinately where it is required and no company has had to go out of business, been in dire stress because they have had to put in a closed cycle.

Am I correct so far?

DR. MORRIS: Is the figure of around 12 to 15 percent a reasonable one to you for closed cycle cost increase, Mr. Rainwater?

MR. RAINWATER: No, it isn't here. I think we will have to talk about what you mean by the fraction to cost. Probably something in the neighborhood of 5 percent in terms of the production cost of electricity, maybe less than this dependent upon your device.

DR. MORRIS: I am talking about the amortization of capital costs and the whole works. I have heard the figure 15 percent many times.

MR. RAINWATER: No, that is very high.

MR. STEIN: What would this mean in cases where you have done this, Mr.Rainwater, on a closed cycle? How much would it add, say, to the consumer, to the home consumer, if he were paying, say, a dollar for electricity? How much would he pay if a plant had to put in a closed cycle, instead of a dollar?

MR. RAINWATER: We have made some of these studies--

MR. STEIN: I know you have, that is why I asked. (Laughter.)

MR. RAINWATER:--on the Michigan area here.

MR. STEIN: But I don't know the answer. I know you have done the studies, but I don't know the answer, I really don't.

MR. RAINWATER: Well, in terms of the actual cost here in mills per kilowatt hour, and this includes the whole shebang here, they are running something from about, oh, .03 or .04 mills per kilowatt hour up to maybe, using another type of device,0.1 mills per kilowatt hour. Let me see if I--

DR. MORRIS: How about percentages?

MR. STEIN: Can you put that in real money?

DR. MORRIS: Yes. (Laughter.)

MR. STEIN: About, you know.

MR. RAINWATER: I would say it is about 1 percent.

MR. STEIN: One percent on the bill? In other words, if I were paying $1 for electricity, I would pay $1.01 if they had a closed cycle?

MR. RAINWATER: I have a table.

MR. STEIN: O. K. Again I don't know.

MR. RAINWATER: This is a maximum economic penalty for various types of cooling systems based on the study. Using a wet mechanical draft tower it is about 1-1/2 percent. A wet natural draft tower 2 to 3 percent.

DR. MORRIS: That includes capital costs and operating costs and--

MR. RAINWATER: This is the whole thing, this is the whole works.

MR. BARBER: Excuse me, is this cost of production or final cost to the consumer?

MR. STEIN: Cost to the consumer.

MR. HARRISON: You have certainly got a different table than I have heard.

MR. RAINWATER: Cooling ponds less than 1 percent, spray canals 1 percent, and then you can get into the dry type devices, which we only have one in this country at the present time, that goes up somewhere around 10 percent. But I think we are talking about those two.

MR. STEIN: In the Mississippi valley you don't think we need dry devices?

MR. RAINWATER: No, we don't.

MR. STEIN: Right. In other words, again let me get this, if I understand you. Even at present costs of putting these in, if they had to put in the most expensive system would be closed cycle, instead of paying a dollar, for every dollar the consumer would pay for electricity he would pay $1.02?

MR. RAINWATER: Yes.

MR. STEIN: All right.

MR. MARTIN: Mr. Rainwater, T V A in our region would be the one most vitally affected by the establishment of a temperature standard. And, of course, this cost has always come up when we talk about temperature standard. The figures that you have given out are quite different from the figures that we hear from the Tennessee Valley Authority. Now, is there some reason for this?

MR. RAINWATER: I haven't looked at the TVA figures from the standpoint of making this type of comparison here. I know that the TVA system does use closed cycle cooling. The Paradise plant is one of the first natural draft tower situations here.

MR. MARTIN: And one other observation. You mentioned that you didn't feel like there would be any meteorological problem involved in your cooling tower?

MR. RAINWATER: Correct.

MR. MARTIN: Is this correct? Well, in Chattanooga at the present time fog presents an awful problem to them and we are just talking about a temperature differential between the tail waters and the natural temperature of the waters above the dam. I still have some question in my mind about no problems involved meteorologically with open tower cooling.

MR. RAINWATER: I think you have to consider this, that Chattanooga and the topography and the climate is quite different than the climate and the topography in the Mississippi River valley here.

MR. MARTIN: But we are still in the Mississippi River valley, though.

MR. RAINWATER: Basing--I was referring to the main stem.

MR. MARTIN: I am sorry, I got the wrong location.

MR. RAINWATER: No, I would never say that you should completely disregard this fog problem. I will say that it can be avoided in almost all instances by local meteorologic surveys in advance. Now, you can stay away from these bad spots. What I was referring to was the fact that we have had this study made that gave us the potential for fog problem based on meteorologic conditions.

Now, in the Chattanooga area and the Appalachian area there is the highest potential fog problem, whereas the Mississippi valley here is in the lowest category. Now, even given those facts, with a high potential based on meteorologic, relative potential, we have these towers operating throughout. In fact, we have more experience with natural draft cooling towers in the Appalachians than anywhere else, and the fog problem hasn't shown up, it hasn't developed. This is just a historic fact. So my deduction is based on that.

MR. MARTIN: Thank you.

MR. STEIN: Are there any other comments or questions?

MR. DICKSTEIN: I have a point.

MR. STEIN: Yes.

MR. DICKSTEIN: Cincinnati Gas and Electric Company is putting a large nuclear plant at Moscow just above Cincinnati. Now, at the time we were discussing that plant Mr. Rainwater's group figured that it would add to the average bill of the average family in Cincinnati approximately 26 cents per month. Recently CG&E published their own figures in the Sunday supplement and they indicated only 13 cents per month.

MR. STEIN: I think Rainwater's estimates always are on the most.

MR. DICKSTEIN: That is correct. I mean I wanted to show that, here is a power company.

MR. STEIN: This would fit in. When we ask Mr. Rainwater for his estimates, you would expect that, we ask the maximum this would raise the bill, and if he is right, in the small cases it would come out less.

MR. DICKSTEIN: This is the power company's own figures.

MR. STEIN: Are there any other comments or questions? Do you want to go, Mr. Zar?

MR. ZAR: Well, I can make a few comments, I suppose.

(Mr. Zar's complete report follows:)

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MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

USEPA, REGION V, WATER QUALITY OFFICE

TO : Robert Hartley, Director, Office of Enforcement & Cooperative Programs

DATE: March 2, 1971

FROM : Howard Zar, Technical Services

SUBJECT: Background information on power development and cooling capacity of the Upper Mississippi River main stem in relation to proposed standards.

The following comments are primarily based on the reports by Battelle Northwest (Ref: "Potential thermal effects of an expanding power industry", Peterson and Jaske - June 1970; " A test simulation of potential effects of thermal power plants on streams in the Upper Mississippi River Basin," Peterson and Jaske - Dec. 1968) and on FPC data.

The present temperature proposal contains a 5° F rise over natural temperature as its most stringent requirement. At the most restrictive, the 5° F rise could be applied at the pipe and would be likely to achieve open-cycle cooling systems such as those being built on plants in Minnesota. These systems reduce heat input but not the amounts of river water passing through condenser and cooling systems. Any damage to organisms due to passage is thus, if anything, more severe than for a once-thru system.

If a tight mixing zone is utilized such as the 600 foot restriction in Illinois Release TR 20-22, the effect is to produce at least for the near future, discharge structures using high-speed and multiport diffusers. As an example, the Quad-Cities Power Plant of Commonwealth Edison Company will use a diffuser system patterned after the Brown's Ferry Plant of TVA. Company officials indicate that they expect the diffuser to achieve compliance with the 600 foot restriction. As heat discharge into the river increases with power industry growth, auxilary cooling might be necessary.

If a looser mixing zone is adapted, it is clear that the 5° F restriction and the standard in general will not cause the construction of cooling towers at least for a number of years. Some results of model studies and power projections are described in the following, which indicate that in certain areas river temperature will be raised up to the 5° F limit. The use of models is open to the usual objections but the absence of any consideration of thermal discharges from sources other than the power industry may tend to make the projections conservative.

Table I is an estimate of main stem capacity based on FPC data(See January 8th memo). The 1986 and 1996 figures should be viewed as approximate.

Table II is an FPC estimate of generation for the important generation areas along the Mississippi River main stem (see Figure I).

Based on these figures one can draw the general conclusion that main-stem

5010-108

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installed capacity/from the head waters to Alton is about 5000 MW_e now and will double roughly, once every ten years until it reaches 25,000 MW_e in the 1990's. Using a rule of thumb of 1.2 cfs/MW_e for water use and assuming that auxilary cooling will be open cycle it appears that the amounts of main stem river water flowing through condensers is about 6000 cfs now and will increase to 30,000 cfs in the 1990's. Additional electrical capacity on the tributaries increases the water use figures dramatically.

Table II indicates basin installed capacity to be about 28,000 MW_e now and increasing to over 100,000 MW_e for 1990. The use of the 1.2 cfs/MW_e is not warranted here, however, as use of lakes and closed cycle cooling systems are anticipated.

By comparison, average main-stem discharge at Winona (MP 725.7) is 24,810 cfs, Clinton, Iowa (MP 511.8) is 46,840 cfs, and at Alton, Illinois (MP 202.7) is 92,740 cfs. It would appear that significant proportions of Upper Mississippi River flow will be passing through condensers under the proposed standard, regardless of the mixing zone interpretation applied.

Table III summarizes the **Battelle** model results for heat capacity (Peterson and Jaske - June 1970), assuming the river can be raised 5°F above natural and that no heat discharge smaller than 800 MW_t (2.6 Billion BTU/hour or a 400 MW_e nuclear plant) can be applied. To make Table III Comparable, to the others, note that dividing through by 2 gives nuclear capacity in MW_e at present efficiency levels while for new fossil units $MW_e = MW_t$. Looking twenty years ahead, it is appropriate to consider Tables I, II, and III as all being in the same units.

Taking the 42,000 figure from Table III, therefore, for the Mississippi River main-stem, it is clear that the 1990's figure of 25,000 MW_e used earlier is comparable and that a ten year doubling rate will soon result in waste heat production that exceeds the upper river's 5°F capacity during parts of the year. These effects will be mitigated by the use of open-cycle systems in the Twin Cities area and in other areas as the 5° F level is approached. It is fair to say though that sections of the river at Twin Cities, Quad-Cities and eventually other areas will be raised near the 5° F during portions of the year under these standards. According to Battelle, closed cycle systems will be necessary at Twin Cities by the 1980's. A projection for the river at Alton is shown in figure 2 from the 1968 Battelle Report under similar assumptions to those given above.

Conclusions

It would appear that the proposed temperature standard will allow sufficient heat discharge and water use by the end of this century to, at times, raise portions of the river down to Alton near the 5° F limit and to run a substantial fraction of the main stem flow through power plant condensers.

Comments

The COLHEAT model used for the heat capacity and temperature projections has been subject to some criticisms. Our Corvallis Laboratory and Northwest Region have developed another model of a similar nature which might be used to check the Battelle results if such effort seems warranted.

This memo was rapidly prepared and could use additional scrutiny. Another version of these comments might be appropriate for the Illinois board hearings in April.

Howard Zar

Howard Zar

TABLE I

Upper Mississippi River Main Stem

	Jan. 8, Memo			
	MWe Installed	MWe Installed	MWe Installed 10 year Doubling (Projected)	
	1971	1976 (Projected)	1986	1996
Minn.	1751	3901	7802	15604
Wisc.	941	947	1882	3764
Iowa	1038	1038	2176	4352
Illinois	931	1740	3520	7040
Missouri	-	-	-	-
Totals to Alton	4690	7640	15280	30560
Illinois (Below Alton)	1698	1698	3394	6788
Missouri (Below Alton)	995	2195	4390	8780
Totals to Cairo	7383	11533	23064	46128

TABLE II

Tabulation of FPC West Central Region Projected Generation Patterns (Ref: Jaske-June 1970) See Figure for Location of Generation Areas

	Generating Capacity in MW_e		
FPC Generation Area	1970	1980	1990
8 St. Cloud, Minn. Area	78	78	51
10 Twin Cities Area	2618	4807	11,339
37 La Crosse Area	680	1220	1120
14 Dubuque-Clinton Area	429	998	2514
21 Quad-Cities Burlington Area	1512	3681	7761
22 Keokuk Area		0	2400
Totals			
To Alton	5327	12,764	25,185
26 St. Louis Area Missouri Side (Below Alton)	2607	7570	9970
27 St. Louis Area Illinois Side (Below Alton)	1715	3365	5765
Totals to Cairo	9649	23,699	40,920
43 Madison, Wisconsin Area (Mostly Lakes)	641	1695	3549
Entire Basin Above Alton	28,400	56,800	110,000

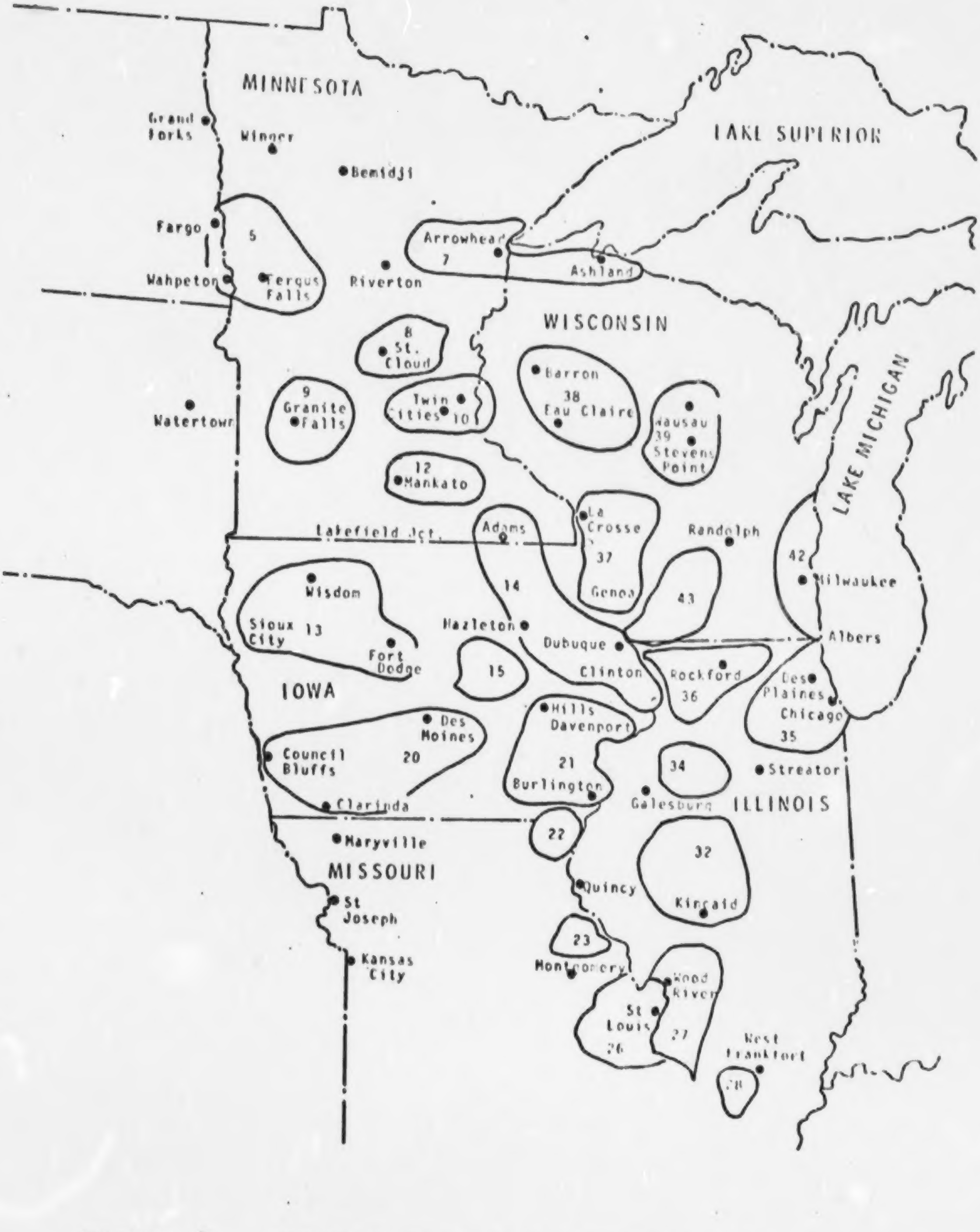
MINNESOTA
Grand Forks
Winger
Bemidji
LAKE SUPERIOR
Fargo
5
Arrowhead
7
Ashland
Wahpeton
Fergus Falls
Riverton
WISCONSIN
8
St. Cloud
Barron
38
Eau Claire
9
Granite Falls
Twin Cities
10
Wausau
39
Stevens Point
Watertown
12
Mankato
LAKE MICHIGAN
La Crosse
37
Genoa
Lakefield Jct.
Adams
Randolph
42
Milwaukee
14
43
Wisdom
Sioux City
13
Fort Dodge
Hazleton
Dubuque
Albers
15
Clinton
Rockford
36
Des Plaines
Chicago
35
IOWA
Hills
Davenport
Des Moines
Council Bluffs
20
21
Burlington
34
Streator
Galesburg
ILLINOIS
Clarinda
22
Maryville
MISSOURI
32
Quincy
Kincaid
St Joseph
23
Kansas City
Montgomery
Wood River
St Louis
26
27
West Frankfort
28

FIGURE 1. FPC-West Central Region Generation Areas

TABLE 3. Summary of Average and Low Annual Cooling Capacities (MW_T) of Upper Mississippi River Basin to Alton

	April, avg	Nov, avg,[c]	April, low[c]	Nov, low[c]	1970 Steam Generating Capacity, MWe
Minnesota River[a]	4,500	350+	350+	100+	1,622
St. Croix River[a]	7,800	3,100	1,800	750+	598
Chippewa River[a]	7,300	2,900	2,800	1,100	None
Wisconsin River[a]	11,700	7,000	5,600	2,500	166
Rock River[a]	6,800	3,000	2,200	650+	570
Cedar Iowa River[a]	7,000	1,700	650+	250+	382
Des Moines River[a]	7,400	500+	250+	100+	683
Illinois River[a]	33,000	20,000	12,000	4,000	3,702
Mississippi Main Stem River[a]	100,000	49,000	67,000	42,000	4,300
Upper Mississippi River Basin[b]	130,000	61,000	79,000	46,000	28,400

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a. *Independent capacities*
b. *Integrated capacities*
c. *Maximum assimilative capacity given where total is less than 800* MW_T

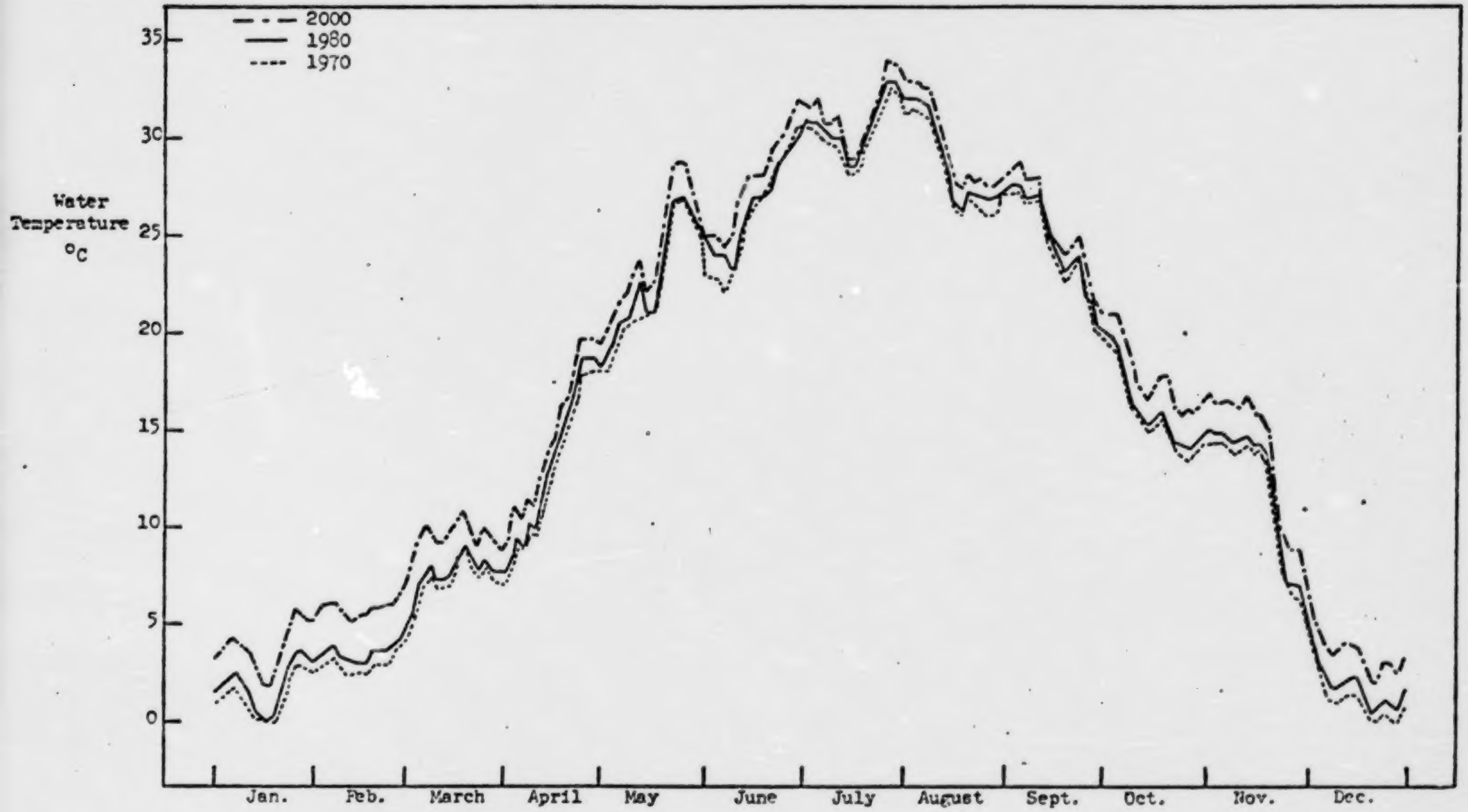

FIGURE 2. Computed Daily Water Temperatures at Alton, years 1970, 1980 and 2000

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USEPA, WQO, REGION V

Director, Water Quality Standards
Ohio Basin Region
THRU: Acting, Director
Office of Enforcement & Cooperative

January 5, 1971

Howard Zar, Physical Scientist
Office of Technical Programs
Technical Services Branch

Steam-Electric Generating Plants Discharging to the Mississippi River, States of Iowa, Missouri, Illinois, Wisconsin and Minnesota

The information requested in your memo of December 11, 1970 and subsequent phone conversations is attached.

Primary sources were.

1. Steam Electric Plant Construction & Annual Production Expenses - 1968 - Federal Power Commission S-199 - November 1969
2. Tabulation of Scheduled & Planned Changes in Installed Generating Capacity - Chicago Power Region - Chicago Office FPC - August 1970
3. Personal Communication with Chicago FPC Office - 1/6/1970 (610 South Canal, Chicago - 8-312-353-6793)
4. Information supplied in your 12/11/1970 memo.

Load factors were taken as 1968 values or as 0.8 (for new plants). Errors may exist in information on smaller plants and on recent or projected capacity changes.

Howard Zar

Attachments:
Tables (5)

cc: Director, LSBO w/attachments
Director, LMBO "
J.H. Rademacher, USEPA, WQO, Region VI - Kansas City, MO w/attachments

HZar/ls

STEAM ELECTRIC PLANTS DISCHARGING TO THE MISSISSIPPI RIVER

PLANT	COMPANY	LOCATION	MW CAPACITY	ESTIMATED LOAD FACTOR	TYPE	YEAR IN SERVICE	MILE POINT
Clay Boswell	Minnesota Power	Cohasset, MN	150	.78	Fossil	1958	
			350		"	1973	
Elk River	Rural Co-op	Elk River, MN	48	.41	"	1951	
High Bridge	Northern States	St. Paul, MN	464	.61	"	1924	840
Island	Northern States	St. Paul, MN	20		"	Operating	841
Southeast	Northern States	Mpls., MN	30		"	Operating	
Riverside	Northern States	Mpls., MN	518	.48	"	1911/1916	
Red Wing	Northern States	Red Wing, MN	23		"	Operating	790
Winona	Northern States	Winona, MN	26		"	Operating	724
Monticello	Northern States	Monticello, MN	472 (Cooling Tower)	.8	BWR	1971	
Monticello	Northern States	Monticello, MN	680	.8	Fossil	1976(?)	
Prarie Island	Northern States	Red Wing, MN	560 (Cooling	.8	PWR	1972	798
			560 Tower)	.8	PWR	1974	798

PLANT	COMPANY	LOCATION	MW CAPACITY	ESTIMATED LOAD FACTOR	TYPE	YEAR IN SERVICE	MILE POINT
French Island	Northern States	LaCrosse, WI	25	.26	Fossil	1940	700
Nelson Dewey	Wisconsin Power	Cassville, WI	227	.75	"	1959	608
Alma	Dairyland Power	Alma, WI	188	.76	"	1947	
Genoa	Dairyland Power	Genoa, WI	15			Operating	678
Stoneman	Dairyland Power	Cassville, WI	52	.48	"	1950	606
LaCrosse	Dairyland Power	Genoa, WI	50	?	BWR	1967	678
Genoa	Dairyland Power	Genoa, WI	384		Fossil	Operating	678

PLANT	COMPANY	LOCATION	MW CAPACITY	ESTIMATED LOAD FACTOR	TYPE	YEAR IN SERVICE	MILE POINT
Grand Tower	Central Illinois	Grand Tower, IL	216	.58	Fossil	1922	
Cahokia	Union Electric	Monsanto, IL	300		"	Operating	
Quad-Cities	Commonwealth Edison	Cordova, IL	809 809	.82 .82	BWR BWR	1971 1972	501 501
Alton	Alton Box Co.	Alton, IL	23			Operating	204
Moline	Iowa-Illinois	Moline, IL	99	.40	Fossil	1887/1913	485
Venice #2	Union Electric	E. St. Louis, IL	500	.50	"	1942	
Wood River	Illinois Power	Wood River, IL	650	.66	"	1949	198
Wood River	Oil Companies	Wood River, IL	32		"		198

PLANT	COMPANY	LOCATION	MW CAPACITY	ESTIMATED LOAD FACTOR	TYPE	YEAR IN SERVICE	MILE POINT
Riverside	Iowa-Illinois	Iowana, IA	244	.74	Fossil	1925	487
Burlington	Iowa-Southern	Burlington, IA	212	.8(?)	"	1968	403
Muscatine	Municipal	Muscatine, IA	125	.57	"	1923/1930	453
Dubuque	Interstate Power	Dubuque, IA	91	.44	"	1904/1926	580
Kapp	Interstate Power	Clinton, IA	237	.46	"	1947	514
Lansing	Interstate Power	Lansing, IA	64	.47	"	1948	?
Montpelier	East Iowa Co-op	Montpelier, IA	65		"	Operating	468

PLANT	COMPANY	LOCATION	MW CAPACITY	ESTIMATED LOAD FACTOR	TYPE	YEAR IN SERVICE	MILE POINT
Meramec	Union Electric	St. Louis County, MO	923	.78	Fossil	1953	
Mound	Union Electric	St. Louis County, Mo	40		"	Operating	
Ashley	Union Electric	St. Louis County, MO	70		"	Operating	
Rush Island	Union Electric	Jefferson County, MO	600	.8	"	1975	
			600	.8	"	1976	
South River	N.W. Missouri Co-op	South River, MO	15		"	Operating	321
Hannibal	Municipal	Hannibal, MO	34		"	Operating	308
Hercules	Hercules Powder	Clarksville, MO	23		"	Operating	273

HOWARD ZAR, PHYSICAL SCIENTIST
EPA - TECHNICAL SERVICES
CHICAGO, ILLINOIS

MR. ZAR: I prepared an internal memo that included a lot of figures and some tables that covered projected generating capacity along the upper river, especially above Alton, and referring to the modeling work by Peterson and Jaske at Battelle Northwest, discussed, I guess briefly, the kinds of temperature effects that would be expected riverwide, and I guess I won't have time to go into it, but the kind of general conclusions I came to were that the 20 years or so that applying standards such as the one that is proposed, something like half or 30 percent, or something on that order, of the river water in the main stem would be passing through condensers on the way from the headwaters to Alton and that substantial portions of the river, especially near the Quad Cities and near the Twin Cities and certain other areas, could be raised up close to the 5-degree Fahrenheit maximum during certain critical times of the year, and that would be in November mostly.

These kinds of projections are kind of dangerous and you shouldn't believe me until you see these numbers, I don't suppose, so I don't--

MR. STEIN: What are you suggesting, if we had the 5 degrees that except for some places like the Quad Cities and certain places where they get close all they will have to do is put in one cooling device to meet the requirements?

MR. ZAR: Well, for example, at the Quad Cities Powerplant, which I think is the largest powerplant now close to operation, Commonwealth Edison has now changed its discharge structure and is going to put in a high speed diffuser system, like the one they are going to use for Lake Michigan, and they indicate they can reach 5 degrees within 600 feet of the point of discharge--

MR. STEIN: Yes. Well, I think the--

MR. ZAR: --without any cooling auxiliaries at all.

MR. STEIN: That is what I am saying, if this is the implication here I think this is a good point, that if we are talking in terms of a 5-degree and no further limitation, which may come up later, that you really think given your projections there are going to be very few plants that are not going to be able to do this without cooling devices. Is that your view?

MR. ZAR: That are not going to be able to?

MR. STEIN: Plants are not going to have to put in cooling devices if they have an adroit kind of discharge diffuser and jet system.

MR. ZAR: If the mixing zone is 600 foot or larger.

MR. STEIN: Right.

MR. ZAR: Yes.

MR. STEIN: All right.

DR. MORRIS: How is that affected by the maximum temperature that we are considering here?

MR. STEIN: I don't know. That is what we--

DR. MORRIS: Conceivably that plant could be taken right off the line if the temperature in the river exceeded 83 degrees, they would have no capacity whatsoever.

MR. STEIN: I think we haven't set the maximum yet and I don't know what relation these maximums will go to the 5 degrees. But I think what Mr. Zar has said, if we are talking in terms of 5 degrees, with what I think maybe most people would think a relatively minimum mixing zone of 600 feet--and maybe that's reasonable for the river, I don't know--in his view cooling devices would not have to be utilized except if you start building one plant on top of another.

MR. ZAR: And I said also that that will happen in places like Twin Cities and the like.

MR. STEIN: Right. But this may be a requirement. I think again you are going to have to consider this, this isn't just here or anywhere else. You get two situations with these powerlants. If you are going to permit them to get within a mile or two or three of each other and not space them at least 5 miles apart, you are going to be faced with a heat rise, I think, and you may have to require them to put in devices. So these are two techniques that you can have, either spacing them in the siting or letting them go closer together and putting in their devices.

But you are saying that let's suppose the plants were at least 5 miles apart, they wouldn't have this problem. Or would they?

MR. ZAR: On the basis of a 5-degree restriction only.

MR. STEIN: Right. O. K., we understand that.

Yates.

MR. BARBER: In this connection I might mention that in our discussions at Lake Michigan it became pretty clear from talking to the hydrologists from the Oregon lab that when they do use high speed injectors they do pretty much put all the heat into the river or very close to it. In other words, that the principle is that by agitation they quickly mix it into the receiving water. Therefore, you are going to have the maximum heat loading in the river, the greatest heat input if that type of device is used. I don't know how often, either, they can get a 600-foot mixing zone unless they--if they say go out into the river, I don't know how many times this river is wide enough to really allow a 600-foot mixing zone without forming something of a barrier there.

MR. STEIN: These are the problems, of course, that you have to consider.

All right, are we--yes.

MR. MULLICAN: I think this poses two problems. The barrier that you speak of and also what if they cut off on the weekend, then you have got a situation in the wintertime possibly that you get the shock from this.

DR. MORRIS: Six hundred feet linear area? That is important in the Mississippi River. Is this 600 feet down the channel?

MR. ZAR: The man at the power company said linear, any direction.

DR. MORRIS: Well, see, that really doesn't mean anything.

MR. ZAR: He is basing his conclusions on the studies done by Dr. Kennedy over at--is it Iowa State?

DR. MORRIS: I know what it means, but I mean this group doesn't know what it means, and 600 feet must be described as linear and this gentleman brought up the question, how much of the area outside the channel mixing zone does that affect, does it provide a barrier. Where they are doing it, it doesn't. The river is always wide enough to accommodate that mixing zone in that 600 feet without taking up a[illegible]at area of the river.

MR. STEIN: All right.

Yes.

MR. SCHLIEKELMAN: I would like to just comment that I think we have got a lot of amateurs, really, talking here as far as the powerplants are concerned. I think probably it would have been best maybe when we first arranged this meeting to maybe have some of the experts and some of the power generating plants here at the same time. I know this had been suggested or discussed with some of the people over at a meeting I attended at Rock Island last week, and I know the power company there had asked Mr. Mayo for permission to send someone here, but Mr. Mayo said it was a closed meeting, not open to the public. And yet I think we have a lot of questions that the group here cannot answer. Maybe we would--

MR. STEIN: They tell me, Schlick, like war is too important to be left to the generals, regulating the power industries is too important to be left to the power companies. That is why we brought Mr. Rainwater here. Now, I don't know what we can do about--you see, here is the problem. Once you open a meeting, and this is an official meeting, I have no objection to open meetings and goodness knows I have talked to power people on this and many other subjects, I do that practically every day, we did it yesterday, I did it at breakfast this morning. But the point is once you let the power companies in, then you have the conservationists want to come in, the cities want to come in, and so forth, and you have a different kind of meeting than you have here. There is certainly no objection to asking the power companies in at an appropriate time and we sure want to talk to them.

But that is why we have Frank Rainwater here. Frank and his group have been working on the devices in the power companies and have been going through the same kind of exercises that the power companies do in analyzing structures, rates, costs, and so forth. And under the circumstances, why, I think we have tried to meet this as best we can.

I will say this, and I have said this many, many times, I don't think you can deal with a particular industry without talking to the people from that industry. They know more about their problems than anyone in government is ever going to know.

MR. SCHLIEKELMAN: Murray, I wonder what the difference is between this meeting and the meetings that were held over at Lake Michigan? Weren't the power companies involved on--

MR. STEIN: Yes.

MR. SCHLIEKELMAN: --that conference or hearing?

MR. STEIN: That was a workshop on Lake Michigan. I would suggest, if you communicated with Mr. Mayo, your question should be directed to him.

Are there any other questions?

If not, let us recess for lunch. It is now 25 after 12. Do you think we can be back at a quarter to 2? Let's try it.

(NOON RECESS)

AFTERNOON SESSION

WEDNESDAY, MARCH 3, 1971

MR. STEIN: All right, let's reconvene.

I think we are going to be able to finish. Maybe you want to take a little more time on this first zone or two, but I suspect we are going to have the same questions all over. They gave the same amount of time to each zone. Once we possibly get the principle established by the technical people, I think we will be able to move a lot easier.

Mr. Dickstein, do you want to go on Zone I?

MR. DICKSTEIN: Let's move into Zone I. And it seems to me that the principals in Zone I should discuss it first. We do have some numbers that we would like to place before the group at this time, in essence our recommended numbers, and then open the discussion with the Zone I concerned, primarily Minnesota, so we would lead off with Minnesota's comments on these numbers and then open it to the group. How is that?

MR. STEIN: Go ahead.

MR. DICKSTEIN: These numbers reflect State and Federal data and numbers that will protect the species which are found in this particular reach. And of the species, primarily we will refer to the top 10 species.

(The following table shows the temperature criteria as agreed upon in this discussion:)

THE FOLLOWING TEMPERATURE CRITERIA ARE FOR EVALUATION OF CONDITIONS FOR THE MAINTENANCE OF A WELL-BALANCED FISH POPULATION IN THE MISSISSIPPI RIVER

1. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

2. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

3. The maximum temperature rise at any time or place above natural temperatures shall not exceed 5°F. In addition, the water temperature shall not exceed the maximum limits indicated in the following table:

MISSISSIPPI RIVER WATER QUALITY STANDARD ZONES

	1	2	3	4	5
January	37	40	45	50	55
February	37	40	45	50	55
March	43	54	57	60	60
April	55	65	68	70	72
May	67	75	78	80	82
June	* 80	84	85	87	87
July	* 80	84	86	89	90
August	80	84	86	89	90
September	80	82	85	87	90
October	67	73	75	78	83
November	55	58	65	70	72
December	43	48	52	57	62

* 82 originally recommended

ZONE I

MR. DICKSTEIN: Here are our numbers for Zone I. These reflect very closely the numbers already approved by the Minnesota Pollution Control Board in their standards.

Mr. Anderson?

MR. ANDERSON: Except for--well, July and August it is 86, Minnesota's standards.

MR. DICKSTEIN; Yes.

DR. MORRIS: I didn't hear that. What was their July and August standard?

MR. ANDERSON: 86.

MR. STEIN: 86?

MR. ANDERSON: What is that?

MR. STEIN: What was that standard?

MR. DICKSTEIN: 86.

MR. STEIN: You have got it down to 82?

MR. DICKSTEIN: Our reflected data available from the State, from our data and everybody else's data, indicates that 82 would be more apropos to the existing temperatures, existing maximums.

DR. MORRIS: What do you mean by indicates it is more apropos? Why the difference between Minnesota at 86 and you at

82?

MR. DICKSTEIN: These reflect the highest temperatures recorded from our data, Federal data and the State data.

MR. SCHLIEKELMAN: Question.

MR. STEIN: If they get up the 5 degrees, will they be up over 82 or to natural?

MR. DICKSTEIN: A 5-degree rise would bring them up above the 82, to give them a 5-degree rise over the highest temperature ever recorded.

MR. STEIN: How much?

MR. DICKSTEIN: That would bring them up to about 87.

MR. STEIN: In other words, they would have to put in cooling devices to keep at 82?

MR. DICKSTEIN: Under certain conditions in the stream, yes, sir.

MR. STEIN: Yes.

All right.

MR. BLOMGREN: Are these the existing temperatures in the river, the maximums per month?

MR. DICKSTEIN: Yes.

MR. BLOMGREN: These are existing maximums?

MR. DICKSTEIN: Yes.

MR. BLOMGREN: And you are saying that should be the limits for that particular stretch?

MR. DICKSTEIN: Yes.

MR. BLOMGREN: The existing maximum should be the limits?

MR. STEIN: Well, under the antidegradation clause, how do you do it otherwise?

MR. BLOMGREN: O. K.

MR. STEIN: I am ready to listen. In other words, you don't find any temperatures of higher record than 82?

MR. DICKSTEIN: Correct.

MR. STEIN: I don't know if anyone from Minnesota is here. Are they?

MR. DICKSTEIN: Yes, Mr. Anderson.

MR. ANDERSON: I am here.

MR. STEIN: What you are suggesting, what they are suggesting in Minnesota, is they keep it to what they found there so far. Do you want to raise that 5 degrees?

MR. ANDERSON: It is not what they found so far because we have lower recorded temperatures than that. I think our high from Itasca to the Rum River was 80 degrees, so they are actually--

MR. STEIN: Where, in the Mississippi?

MR. ANDERSON: Yes. Now, that is above the Twin Cities.

MR. DICKSTEIN: Zone I is above the Twin Cities.

MR. STEIN: In other words, you think an 82-degree rise is--82 is higher than you found?

MR. ANDERSON: Yes.

MR. HARRISON: No, it is lower.

MR. ANDERSON: According to the data we have got.

MR. STEIN: Do you want to lower that to 80?

MR. DICKS[illegible]IN: Do you want to lower it to 80?

MR. ANDERSON: No, we don't want to change it at all, figuring the nondegradation clause is going to take care of--

MR. STEIN: I know you don't want any changes at all, but that is the Federal law. I'm sorry about that.

MR. [illegible]RSON: We have got the nondegradation clause which you insisted on. Now, under our existing standards, if we use the nondegradation clause then there is no reason to change.

MR. STEIN: All right.

MR. DICKSTEIN: Under nondegradation would lock you in at the existing numbers you have right now, but yet you proposed 86 in your standards per se, correct?

MR. ANDERSON: That is right.

MR. STEIN: Dale?

MR. BRYSON: Yes, sir.

MR. STEIN: What do you think the standards should be for Minnesota?

MR. BRYSON: That is quite a question. If these reflect the data as they currently exist, I would like to see his numbers.

MR. STEIN: They don't reflect the data as they currently exist. I would be surprised to find 82 up around there. Did you ever put your hand in that river up there? He says they don't get above 80. I would like to be there the day they get up that high.

MR. BRYSON: There are some data that show--

MR. DICKSTEIN: Some of our data shows 85.

MR. BRYSON: Right, shows a maximum of 85 already.

MR. STEIN: All right. I think you people have to get together on it. At the Twin Cities?

MR. DICKSTEIN: This is above. This is Zone I, headwaters to above Minneapolis.

MR. STEIN: So how do you get it down to 82 if they get up to 85 naturally?

DR. MORRIS: Where did this 85 come in? They have been saying that they only get up to 80. You have allowed them 82. Now, where does the 85 figure come from?

MR. STEIN: That is what I am trying to find out.

MR. DICKSTEIN: It was an isolated reading.

MR. ANDERSON: From the data that we had submitted to us we had 80, I believe was the highest, in that stretch above the Rum River.

MR. STEIN: Then why did you ask for 86 if all you get up to is 80 natural?

MR. ANDERSON: I didn't make the policy.

MR. DICKSTEIN: The Board passed it.

MR. STEIN: Why do you pick 82?

MR. DICKSTEIN: More or less on the data available and recognizing that there was a few isolated numbers, this 85 number.

MR. STEIN: Well, if they don't get above 80, why do you want to go to 82?

MR. BRYSON: There are numbers above the 80's.

MR. STEIN: They have an environmentalist in charge now, Grant Merritt, in Minnesota. I don't think he wants to associate himself with deteriorating the water quality.

MR. DICKSTEIN: We show here in Anoka in July the temperature did reach 84, in August it reached 82.

MR. STEIN: When, how many years?

MR. DICKSTEIN: This is some of Dale Bryson's figures.

MR. BRYSON: This is just the maximum recorded, Mr. Stein, at--

MR. STEIN: Once?

MR. BRYSON: I don't have the full array in front of me, so I am not sure what it is. Tom, do you have all of the data handy? We can check it out real quick.

MR. POWERS: Yes, let me get it.

MR. STEIN: If Minnesota doesn't want this higher than 80--

MR. ANDERSON: I didn't make that statement. (Laughter.) I am just saying that under the existing non-degradation clause we shouldn't have any problem anyway, if that is enforceable.

MR. STEIN: But if we have a nondegradation clause we have to know what we are starting from. Do we understand that in Zone I under the nondegradation clause--

MR. ANDERSON: I just wonder, is Anoka in Zone I or Zone II? I don't know where the station is.

MR. DICKSTEIN: Zone I goes down from the headwaters to the Rum River.

MR. ANDERSON: That is right at Anoka.

MR. DICKSTEIN: That is right at Anoka.

MR. STEIN: Anoka Bridge. O. K.

The point is, can we say that in Zone I, except for rare occasions, this doesn't get above 80 and the maximum temperature is going to be 80 in there unless it is raised by natural conditions, which will happen rarely? If that is what Minnesota wants, I guess we are ready to go with it. Why don't you knock those two figures in July and August down to 80 and we can go to Zone II. I wouldn't think that anyone would want to argue with it.

All right.

I know Grant Merritt wants the lowest possible figure on short disposal. All right.

Let's go to Zone II.

ZONE II

MR. DICKSTEIN: These are the numbers recommended for Zone II.

MR. STEIN: All right, give them the scope of this so the States involved can get the point.

MR. DICKSTEIN: Zone II is from the Rum River down to the northern Illinois boundary, so it includes a portion of Iowa, once again Minnesota, and Wisconsin.

MR. HARRISON: Is that August figure 89 or 84?

MR. DICKSTEIN: 84. 84 is the maximum.

MR. HARRISON: That is a maximum figure.

MR. DICKSTEIN: 84 is the present maximum temperature in the State of Wisconsin.

MR. ANDERSON: We have got several deals over 84, river mile--

MR. DICKSTEIN: Yes, we have.

MR. HARRISON: We have 88, 85.

DR. MORRIS: Our temperatures are higher than that, aren't they?

MR. HARRISON: Why, sure they are.

DR. MORRIS: We exceed this. Get on your feet and say so.

MR. DICKSTEIN: An isolated number of 87.

MR. STEIN: When did you get 85? How many of the numbers are 85?

MR. DICKSTEIN: One isolated 87.

MR. STEIN: Were the rest below?

MR. DICKSTEIN: The rest were 84--

MR. STEIN: Let me make it clear on these requirements. If you ever get hot enough natural to go over these so-called isolated numbers, this is not what we are controlling here. In other words, we all recognize that if it is in the other place than here that something can go up to 87 and if you don't have any control over that, you don't.

Now, is 84 reasonable in this area or not? Yes?

MR. HARRISON: Not right.

DR. MORRIS: It is my understanding our figures exceed that. I would like to have Mr. Schliekelman discuss it. He has the data in front of him.

MR. STEIN: That is why we are here.

MR. SCHLIEKELMAN: Why did you pick Wisconsin data when we submitted a lot of data which indicates that we are up to 88 degrees at Dubuque, which is at the lower end of this Zone II area?

MR. STEIN: To whom did you submit this, Schlick?

MR. SCHLIEKELMAN: This was submitted to Mr. Zar here several weeks ago.

MR. DICKSTEIN: You have got the data, haven't you?

MR. POWERS: Yes, it is here.

MR. STEIN: What do you think of that?

MR. SCHLIEKELMAN: We have data actually going back to this November data, that is the maximum 58 degrees, and we have here temperatures in November that have gone up to 60 degrees even in some of the winter months.

MR. STEIN: Yes, I see your data. Let's take one at a time.

Can we all agree that Iowa submitted these figures?

MR. POWERS: Yes.

MR. STEIN: All right, why didn't we accept them or why didn't you accept them?

MR. POWERS: We went over it last night.

MR. HARRISON: Speak louder, please. I don't know what you are saying.

MR. POWERS: In going over these charts, we went over all these numbers in the thing, and we have also got a plot and the 87 appears on the plot. We do have that number. But, now, these numbers, I don't know where they came from.

MR. HARRISON: You don't know where they came from. Neither do we.

MR. STEIN: Wait a minute. Wait a minute.

DR. MORRIS: We would like to find out.

MR. STEIN: So would I.

Go ahead.

MR. DICKSTEIN: The other numbers, we have scattered--we have all kinds of data from all kinds of sources, they are scattered data, and on our plots the 87 is an isolated--shows this as an isolated incident here, where everything else essentially falls under the plot line.

MR. SCHLIEKELMAN: Well, for the first chart I am looking at here for 4 years we have every year is above 85 degrees. We have two in '56, 87 and 88; '57, 86; '58, 85; and '59, 86. I don't think these are any isolated cases. These are the highest temperatures which occurred during those particular years, particular months.

We have an 86 also in 1960. And one also in 1964.

MR. DICKSTEIN: How long did those numbers hold up? Because they are your data. What was the length of time?

MR. SCHLIEKELMAN: This was the highest during that particular month.

MR. DICKSTEIN: The highest during that particular month?

MR. SCHLIEKELMAN: Yes. Say during this time we had 88--

MR. DICKSTEIN: What was the duration?

MR. SCHLIEKELMAN: --during this month we had 88 degrees, it varied from 79 up to 88 degrees.

MR. STEIN: How long did it continue, Schlick?

MR. SCHLIEKELMAN: I don't know. These are the highest during those particular months. In the case of Clinton, which is downstream, we do have actually frequency data, that is duration data, but we don't have them for this particular data here.

DR. MORRIS: Let's ask the question in reverse. If this is information for enforcement, are you going to permit us or any measurement group to measure an 87 or 88 and say, well, fellows, it doesn't exist for very long, it is a spurious piece of data, we will disregard it? Or are we going to be held legally to exceeding this?

MR. STEIN: No. There are several ways you can do it. If you go up to 88, maybe you can go up to 88 two hours every month during August and that is all.

DR. MORRIS: But I mean I at least have not seen any criteria that permits us to do this.

MR. STEIN: No. That is why we are here.

Dr. Morris, you know, this is the situation and what I wanted to get back on. Let me take this opportunity to try this on you again.

If you are going to get a plant operator, and to cut through some underbrush let's assume for the sake of argument he is going to be a powerplant operator--

DR. MORRIS: Excuse me. Can I turn this off? I can't hear you either, Murray.

MR. STEIN: Yes, turn it off.

Let's assume, for the sake of simplifying this, that he is a powerplant operator. Let's assume you have some mixing zone and you may go to 600 linear feet, or wherever you want to go, and we will assume that under certain conditions this guy for a short period of time may go up to 86, 87 or 88 during the periods that you indicate, and you make this judgment that this can go up for a particular period of time, if we hold this guy responsible for what is coming out of his pipe and we assume the responsibility, as I am saying, the public agencies, the State agencies and the Federal agencies, that if we give this man a requirement that something is coming out of his pipe, we are going to figure maybe during July, and I don't have the duration you are going to have to put this up, but let's suppose that during July for maybe 10, 12 hours at various times during the month, or maybe it is 20 hours or 30 hours, he is going to be up to 88 degrees, I think that might be a reasonable assumption. But the point is, you have to indicate, giving all the natural conditions, and expecting him, say, to come down--what did you have on this one, 84?

MR. DICKSTEIN: Yes.

MR. STEIN: Let's assume that that 84 is the reasonable operation, under all reasonable conditions this guy is going to meet 84, but there are going to be conditions for several hours during several months that he is going to go up to 85, 86, 87 and sometimes even as high as 88. Why can't we set something up like that?

DR. MORRIS: I am just trying to get this clear.

MR. STEIN: Yes.

DR. MORRIS: I am truly not trying to be argumentative.

MR. STEIN: Yes.

DR. MORRIS: If we accept this 84 or 88 such as Mr. Schliekelman just demonstrated, what you are saying is that there will be periods where exceeding of, say, this 84 figure would be acceptable over a yet to be established period of time?

MR. STEIN: No, I think we would have to set this up.

But the difficulty, you see, if we take the maximum figure of 88 and let these guys go up to 88, let's assume that it is 10 hours during July and 10 hours during August that they are ever up to 88--in other words, except for a few specialized circumstances, we should be able to be to 84 and below.

DR. MORRIS: I recognize this and I accept it. What you have to define is the length of time of the excursion.

MR. STEIN: Let me try to work on this just a little more. And this is why I think these mixing zones or the figures you have put out should largely be a theoretical operation.

Let us suppose that if you are going to get 84 day in and day out, you are going to let these guys--and I don't know whether 600 linear feet--let's suppose they can put it out what, at 88 or 89? You have got 84? Let's say they put it out, just for the sake of argument, at 89, right? You figure they are going to get 84 almost all the time during this operation. You tell the plant at the pipes they have to put it out at 89 or 88 or 90, whatever you have. You have got to recognize there are going to be climatic conditions, the flows of the river, where if the plant is putting it out at 89 that 99 percent of the time you are going to be 84 percent and below. Sometimes you are going to get up to 85, sometimes you are going to get up to 86, sometimes you are going to get up to 87, and very few times you are going to get up to 88. But as long as that guy puts it out as 89, our responsibility, that is the State and the Federal, is going to be to protect that river, that you are going to keep it within 84 amost all the time, and when they get up, recognizing the fluctuations, to 86, 87, 88, sometimes we just have to accept it. Now, if we find that giving him the 89 degrees that he is going to get above that 84 too frequently, which is going to harm the biota, then maybe we will have to roll him back.

But this is the concept that I was trying to put across, to try to give the flexibility in this zone and to recognize that when we say 84 under certain climatic conditions we are not going to have 84 365 days of the year 24 hours a day. There may be a time when you are going to have a little variation. But the alternative is that if you lower your sights to the maximum allowed by the most vagrant variation, we will be degrading the stream.

This is the issue that I am trying to see if we can come to grips with and come up with a solution.

O. K. Schlick?

MR. SCHLIEKELMAN: I have got one comment on that. Actually, during this month when we had the temperature going up to 87 degrees, the minimum during that particular month was 68 degrees or 19 degrees difference. So there is going to be a high percentage of the time during that particular month where we are going to be a long ways from the maximum temperature.

MR. STEIN: We understand that. But again let me put this, Schlick. We have got these two problems. The one is, and this is what Yates is putting out, the limit when you get to 69, if we give you the 5-degree rise, all you can do is go to 74. And even in the coldest winter months that is all you can do.

But in addition to that, we have superimposed on that a top limitation. And for one reason or another these fellows say that this top limitation for the usual time is going to be 84. Now, I have no brief for that 84.

In the recognition of that 84, if you are going to do that and you are going to spin that out for what usually is the high except for a few aberrations on that and you can run that 84 back to the maximum they are going to have to put out at the pipe, we can recognize that for a few hours of a month this may be higher than 84 and for a few hours, maybe once a year or once every two years, it may be running up to 88.

I don't think there is anything necessarily wrong with that if that is the way you want to go, but I think we would be making a mistake to take that 88 maximum and let everyone go up to that, because then we would ruin the stream. If you are around 60 or 69 most of the time, what the heck would you want to let them run it up to 88 for?

MR. SCHLIEKELMAN: I am not saying we are in the 68 degrees. But we do have this difference and I don't think on the basis of information we have on this particular stream here that we have any idea what the frequency might be at which it might exceed, say, maybe 84 degrees. We do have, I think, enough data some places where we could probably get that.

MR. STEIN: Where do you have it?

MR. SCHLIEKELMAN: I don't think we can complicate it that much by trying to set something below the maximum temperatures that we have had.

MR. STEIN: Are you suggesting, Schlick, as I understand you, that we pick the maximum number we have had, whether it is for an hour, two minutes or five seconds, and we let everyone raise the temperature to that degree?

MR. SCHLIEKELMAN: I don't think we are going to be raising it to that degree only a small percentage of the time.

MR. STEIN: But we should allow them to do it if they want to do it?

MR. SCHLIEKELMAN: I think what we are doing, during this particular month we always have a differential of at least 10 degrees, sometimes 19 degrees, and maybe half the time it will be in that middle range and maybe a fourth of the time it might be up there at the maximum. I don't know whether 10 days at the maximum temperature is going to make that much difference

MR. BARBER: Could I comment here?

MR. STEIN: Yes, Yates.

MR. BARBER: I think in looking at this temperature structure, one of the vital things that we are setting maximum for is hopefully the protection of aquatic life in the stream. If we are allowing a 5-degree rise above natural and if we feel that 84 is as high as we should heat that stream for fear of putting stress on aquatic organisms there, we have to look at how much of the time is the temperature at 79 and 80, 81, 82, 83, 84 and 85, as well as how much of the time it is at 88, because any time the river is at 79, if you give them a 5-degree rise and they use it, you will have pushed your environment up to the 84 level and, therefore, any time that the natural temperature is getting to 80 and 81 and 82 and 83, you are actually pushing your aquatic organisms well beyond the 84 degrees which is considered to be the preferable temperature for them.

As you have indicated earlier today, I think that the 88 is frequently a one-point-in-the-stream reading, which probably, I would judge from what little I know of temperature monitoring stations and the records which I have ever had any participation in, is not the coolest temperature in the stream at the time. If it is either way, it is probably a little bit closer to the warmer side of the picture. And when we have these periods of time that we are going to push these fish on beyond, naturally the fish is probably not in that 88-degree water.

But now when we start talking about letting a power company or a large thermal discharge go into the stream, we had some figures here this morning and looking ahead a bit to the powerplants of tomorrow, when you have 3,000 cubic feet per second discharging at 20 degrees, and that is fairly average for plants, this is actually, if all the heat gets into the river, equivalent to the amount of heat that will increase 12,000 cubic feet a second by roughly 5 degrees. So we are talking about some pretty heavy loadings and we are talking about probably circumstances where we may push much more than just the little thin layer of water on the top of it to 88. We may actually be pushing a pretty big volume of that river up over this 84 degrees, which is the preferred temperature for most of the fish life in that area of the river.

Thank you.

DR. MORRIS: It seems to me in operating a powerplant, if we accept on the basis of what the biological people have presented to us here today, 84 degrees as a safe acceptable temperature for the aquatic life, if we give a powerplant operator 5 degrees fluctuation up to that 84 degrees that we have established and the natural temperature of the river begins to increase so that he no longer has that 5 degrees increment any more, he is going to have to change his plant operation so that he doesn't, from a heat input standpoint, contribute to the length of time that the temperature resides above that 84 degrees.

So it looks to me that if the natural temperature of the river begins to approach this 84, he is going to have to have less and less differential in the temperature that he can put out of his exchange pipe.

MR. STEIN: That is correct. As I understand the proposal, and this is something we have to face, the capital investment in a case such as you point out may go down to where the guy has to put in no degrees of temperature.

DR. MORRIS: That is right.

MR. STEIN: However, as far as operations are concerned, he may save a little on operations, if the temperature conditions are right, by putting out as much as 5 degrees, but when other factors begin to work he has to be able to put down the screws and get this down to practically zero. Now, this is, as I understand, the proposal.

If this isn't what we are going to do, in other words, we can face it. But if the figure is 84 degrees, for example, and the natural comes up to 85, 86, 87 or 88, no one is arguing that these natural conditions don't occur. But once he gets up to 84, he can't put in another degree of temperature from a powerplant.

DR. MORRIS: I don't think we have really been arguing about anything fundamental. If we accept the 84 degrees, it almost looks on any stream that on occasion naturally has excursions above that, the engineer is going to have to design to meet that whatever the frequency of those natural excursions above the 84 gets to be. So what we are really saying is--

MR. STEIN: Yes.

DR. MORRIS: --on a stream like the Mississippi that does fluctuate we are looking at a closed circuit cooling on every powerplant that goes in. The way the question has been discussed, I don't see how we can state it any other way.

MR. STEIN: That is right, I wouldn't dispute that a bit.

Does anyone have any question on that?

I wouldn't dispute that one minute because this is what the proposal is.

Yes?

MR. SCHLIEKELMAN: What has been the biological effect of, say, some of the existing plants under these conditions? We have had a study by the Upper Mississippi River Conservation Committee which indicates that below the--this is a report 1970, this was a plant up at Genoa, this is a 350 megawatt plant, nuclear plant. The heated effluent--actually, they sampled during several periods up there; they came to this conclusion. On the basis of these samples, the heated effluent is apparently not excluding sports fish or producing unusually high concentrations of rough fish in the area below the outlet.

In addition to that, the minutes of the fish technical section of the same 1970 report indicate that of three studies that are now under way by the biologists of the three States, and I am quoting here, to date none of these individual studies have shown any detrimental effects to the fish population.

MR. STEIN: Well, I don't know. Do any of these fellows want to answer that?

DR. MOUNT: Well, I think the explanation lies in some of the things we talked about this morning and that is that these fish do have a place to go if they find the temperature unsuitable and they go there. I think the issue right now is that we not adopt standards which will allow them to put the whole river in a stretch up to that temperature. This is the key point.

MR. BARBER: And I would point out, too, that sometimes fish do concentrate in areas for reasons other than heat, and a real good example of this is the tailwater of an enormous number of dams where fish do concentrate below those dams, partly, perhaps, because at certain seasons they move upstream and they hit a barrier and they reside there a while. In other cases they obviously respond to food, and particularly if there happen to be disabled small fish or other organisms coming through, say, a hydrostation turbine, they frequently concentrate there for food rather than for the warmth that is there. So some of this concentration may not necessarily be because they really prefer the temperature and in some cases there is a suggestion they may be lying down below a plume in a somewhat cooler strata, rising to take the injured organisms or those which have lost equilibrium coming through the plant. I don't say that is the case here, but it is indeed a good possibility.

MR. STEIN: You fellows are going to have to decide this. As far as I can see, if we go to the antidegradation clause, either one or the other, I would agree that this would require the installation of a closed system and the full operation of it all the time. I think what these guys are proposing is some kind of a modification and an easing off on that. In other words, what someone would have to do in order to meet your requirements in Iowa and some of these other places, and I am sure these temperatures go on, in order to be sure they are going to meet them is to put in a closed system, but they won't have to operate that completely all the time because they will be able most of the times of the year to go up to 5 degrees, but there will be times of the year when they will completely have to operate this closed system and they will have to be able to permit no degree rise or essentially no degree rise in the water.

Now, I think this is the operation. If we talk in terms of antidegradation and you are not going to deteriorate the water quality and the assumption that the addition of heat is a deterioration and you have to use the best practical means, and as Rainwater has told us that a closed system can raise the rate 2 cents on a dollar and they know how to work it and that fits within the best practical means, the question we have to offer is whether you want to run that full time or just a portion of the time as proposed here. I think this is the issue you have to face.

Schlick?

MR. SCHLIEKELMAN: Murray, I think we are going to have the same thing on our municipalities. We are going to have a lot of these communities in the wintertime that are going to be raising their sewage discharges at least 25 degrees in a lot of cases. What is going to be done in these particular cases?

MR. STEIN: Here, Schlick--

MR. SCHLIEKELMAN: We are talking about--

MR. STEIN: --I don't believe, in the volume that the municipalities are putting out their wastes, unless I am mistaken, that you can't make a reasonable classification and not regulate the municipalities, particularly the ones you have on the Mississippi River.

MR. SCHLIEKELMAN: Well, we already have had one instance on this, Murray, to the extent where this 1,500--1,400 gallons per minute of heated water from a barometric condenser has been disapproved by the Fish & Wildlife Service. He says, "We have been advised that the Iowa Water Pollution Commission and the Iowa State Conservation Commission have no objections to this application. However, we are concerned since the proposal could damage"--

MR. STEIN: I don't have Yates here. Do you know about that, Mr. Sharp?

MR. SHARP: I wasn't in on that, Murray.

MR. SCHLIEKELMAN: This comes from Twin Cities, Minnesota.

MR. STEIN: I know you have alluded to that several times, Schlick. I am really totally cold on this and I haven't found anyone here.

Do you know about this situation?

Maybe we had better wait for Yates to come back. But I don't visualize any one of these cities that is necessarily under this restriction.

MR. SCHLIEKELMAN: What is the difference between an industry which is discharging less heat than a municipality? The industry in this particular case is probably discharging heat at 10 degrees higher.

MR. STEIN: Schlick, until I hear from these people, I don't know, and I checked this, I really don't know what you are talking about.

The point is, as I read these requirements, where you are below your city or an industry other than a power industry with a relatively low number of BTU's or you are a small powerplant, if this is what you are talking about--is this a powerplant, this industry?

MR. SCHLIEKELMAN: No.

MR. STEIN: Another industry. I would have to hear what they are talking about, but I think we can draw a line between those. Certainly, as far as I am concerned, no one is suggesting that you cool the wastes from Davenport and Clinton.

Yes?

DR. MORRIS: This situation of the industry he is talking about seems to be completely invalid with respect to the concept we have pretty well accepted here that there is a mixing zone to assimilate a thermal waste. It depends upon the total thermal load that you put in. And if this is recognized, that complaint ought to fall flat on its face.

MR. STEIN: We are trying to ascertain what the situation here is. Certainly this wasn't our agency, was it? Or was it?

MR. SCHLIEKELMAN: The Bureau of Sport Fisheries and Wildlife.

MR. STEIN: We will have to ask someone--

MR. SCHLIEKELMAN: It came from Minneapolis.

MR. STEIN: What?

MR. SCHLIEKELMAN: It came from Minneapolis.

MR. SHARP: What is the date of that report?

MR. SCHLIEKELMAN: January 20, 1971.

MR. SHARP: And the industry concerned is what?

MR. SCHLIEKELMAN: It came from Lewis R. Garlick, Acting Regional Director.

MR. SHARP: No, I mean the industry involved.

MR. SCHLIEKELMAN: Grain Processing Corporation, Muscatine.

MR. DICKSTEIN: I assume they are asking for a permit under Section 10 of the Rivers and Harbors Act? Is that it?

MR. SCHLIEKELMAN: He is talking about Section 13.

MR. DICKSTEIN: Section 13?

MR. STEIN: Yes.

MR. SHARP: Of the Rivers and Harbors Act?

MR. STEIN: If it is a Section 13 permit, that goes to the Corps of Engineers; this is not our permit. We make a recommendation to the Corps of Engineers as the other agency. What you are suggesting, Schlick, that here is a permit that went through a completely third agency and you are suggesting that they get a report from the Department of the Interior, which is another agency, and because of that report the Corps didn't operate on that. Now, we will be glad to look into this because it is one government, but the statute isn't administered by us, the report wasn't written by us.

MR. SCHLIEKELMAN: Of course the way this Refuse Act is written up or, rather, the regulation is written up, the Bureau of Sport Fisheries and Wildlife still has the veto power on anything even though it meets--

MR. STEIN: They have got a veto power over anything I do.

MR. SCHLIEKELMAN:--even though it meets water quality standards.

MR. STEIN: Let me tell you, Schlick, if these guys in the Interior Department and the Bureau of Fish & Wildlife are going to say anything we do is going to be harmful to the fish and going to wipe them out, I am going to listen to them. I don't think this is a remarkable fact. And if the Corps does the same thing that I do, I can't fault them either.

The only thing I am telling you is our agency wasn't involved in the particular case that you are talking about and I don't know the basis of the recommendation, but I think it is going to be a real cold day in June when I get a negative report from the Fish & Wildlife Service and overrule them. It just isn't in the cards. And I don't see that the Corps is going to do the same thing. I think you have got to deal with this on the facts.

Do you know, Yates, what this case is?

MR. BARBER: I do not. I would be glad to look into it and see what it is. I would assume that our field people in that region in evaluating this project evidently reached the conclusion that it would have a detrimental effect on fish and wildlife resources if they recommended against the permit.

Now, insofar as the question of the cities discharging and our not having recommended against them, I don't think we have ever evaluated these discharges that have been existing for 20 years. If we did, we must make the same recommendation we did on this small one. I really don't know; I won't say.

But I would be glad to check into it and see what the basis of our recommendation is there. I frankly am just unfamiliar with the particular project.

MR. STEIN: Could we get back to this operation here?

Do you object to a figure like 84 or any figure for a maximum? Or do you have a figure to suggest?

DR. MORRIS: I think on the basis of the way we discussed it, it is a figure that we can live with on the average, and if we are allowed to use judicious and sensible mixing zones, it is apparently an average figure on the river.

MR. STEIN: That is right. I don't know, I may be knocking all the engineers and biologists off their props, but I agree with what you just said, not only average, but it is a computation.

The way I see this operation, what you are going to figure is a figure in the river with what you would consider, if you wanted a reasonable mixing zone, what I call a theoretical mixing zone or what I think Don Mount indicates water in the river has to do to protect the fish or the biota. Once you make that judgment, what you are doing is you are telling a plant operator, you have to put in X facilities or else you are not going to make this under any circumstances. That is A. And B, you are going to have to operate them right.

Again the way I look at this, let us suppose there wasn't a plant on this darned river at all or any people on the river and we decided that around the Iowa portion of the Mississippi River the maximum temperature was 84. I would believe if no one were around but the Sioux Indians there would be times when natural conditions probably would push that up to 88 and nothing you could do or I could do or Sioux City could do or Council Bluffs could do or a powerplant could do, whether we were there or not, would change it. And this is not why we are in there trying to regulate. We should understand that, that when the temperature goes way up and the water temperature goes way up and it would have gone way up whether anyone was there or not, that we are not going to hold anyone responsible for that. I don't think you can. And even if we tried to, I think the courts would turn us down.

All right, if we are in agreement, let's go on.

MR. DICKSTEIN: I want to make a correction on Zone II. The October temperature was 73, not 82.

MR. SCHLEUGER: Is what?

MR. DICKSTEIN: Seventy-three.

MR. SCHLEUGER: October temperature 73.

MR. DICKSTEIN: October is 73 instead of 82.

DR. MORRIS: Of what, Zone II?

MR. DICKSTEIN: Zone II, yes.

MR. SCHLIEKELMAN: I think we have some of the same problems on temperature exceeding those figures in some of the other months besides. November has been 2 degrees over that particular figure.

MR. STEIN: By the way, I think the same principle will obtain any time they exceed the figures for other causes. And it doesn't matter when they exceed these figures. Again let me try and make this clear, and I think we are coming to a close understanding.

No one is going to change a hot November or a December. We can't reasonably expect a State, an industry or someone else to do it. What we are doing with them is putting up a reasonable restraint. Now, the point is if you are going to get these high figures sometimes, this is what you are going to get. And I don't think anyone can put that on a regulatory function or on a powerplant operation. These are aberrations, natural aberrations that we have had all the time.

I dare say before Columbus landed you have had fish kills in this country due to high temperatures. And if you think that we are going to put up a regulatory program to prevent that kind of stuff, I think we are kidding ourselves. And I think we are straining at gnats if we try to do it. This thing has gone on from time immemorial.

Irv.

MR.DICKSTEIN: If you remember, when we had our meeting last month there were three clauses before we went into the maximum temperatures, and I would like to remind you of these clauses. I think it would clarify some of our problems.

No. 1 is that there shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. I think these natural conditions are very important.

If we have a funny climatic condition that particular day or during that season, we consider it natural. So I think that would clarify some of the discussion we are having right now. And these are qualifiers in front of this group.

Also the normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained. So once again these are qualifications.

Then the No. 3 clause, that the maximum temperature rise at any time or place above natural temperatures shall not exceed 5 degrees Fahrenheit and in addition the water temperatures shall not exceed the maximum limits as indicated in the following tables, and these are the new tables that we are working with.

ZONE III

Now, in Zone III we are proposing these numbers, and the key here is to in essence protect the aquatic life that exists in this particular zone and also taking into consideration the existing numbers, recognizing that they are exceeded in several or in some instances, getting back to the principle of the previous discussion.

MR. STEIN: Where is this between? From the Illinois

River--

MR. DICKSTEIN: This is from the northern Illinois boundary down to Alton Lock and Dam. So this would include Iowa, Illinois and Missouri. It would include those three States.

MR. STEIN: Yes.

MR. BLOMGREN: We have no argument with numbers with the proper definitions as we have described them. We think it is important that we identify the intake location, so many feet below the surface, so many feet out in the middle of the stream. However we do it, there should be a consistent point, and we have no argument about discharge.

MR. STEIN: By the way, I think we have got two other points, at least, in the river other than temperature. You know, we are talking about temperature and haggling about this. I have often said this in speeches. I think this is one-third of the problem, and maybe the light touch. I think we have to put the intakes at a point where they are not taking in the plankton, the fish fry at critical periods of the year, the minute organisms, mauling them, bruising them, running them over those condensers and knocking them out.

I think we also have to have the point that they are not going to use a chemical for an antifoulant in addition to the indignity that they suffer when they are pulled in and battered around to put a chemical in and really add to their demise.

Now, the third point is, of course, the heat that everyone is excited about and we are haggling about here. I am glad you brought this up. Sometimes you think you are baying at the moon. I am not sure that the damage we are doing to the biota of the stream by not putting in a properly located intake and barring the use of chemicals as an antifoulant isn't hurting the quality of the waters more than the heat we are talking about and arguing a degree here or a degree there.

I certainly would agree, and as a matter of fact I will say this here: As far as I am concerned, I think for protection of the quality of the waters, the location of the intake so as to minimize the plankton, zooplankton, phytoplankton and fish fry they put in, the elimination of chemical antifoulants will probably be greater measures protecting the quality of the waters than getting a degree higher or lower of the discharge coming out. And I certainly agree that this is a key point that everyone seems to be arguing, they love to argue these numbers on heat. Thermal pollution from heat is what has caught the public attention.

MR. BLOMGREN: You made half my speech, Mr. Stein.

MR. STEIN: Well, I am with you on this, but you know we have to live in our society.

MR. BLOMGREN: What I would like to suggest also is that these comments that you mentioned we hashed through on our Lake Michigan thermal committee, and I would suggest that these be presented to this group because I agree completely that we might be talking about temperature but maybe what we are talking about is no shoreline discharge or maybe we are talking about a certain dispersion structure, and this would balance up this whole business of temperature completely.

MR. STEIN: That is right.

MR. BLOMGREN: We can't divorce ourselves from it.

MR. STEIN: That is right. And I think on the Mississippi you know you have got an easier idea or problem and you may have an easier problem than on Lake Michigan, because in Lake Michigan it may be very expensive to get into some low waters during the hypolimnion for a dispersion. But in the Corps of Engineers permitting, it might not be too difficult to put this gook into the main channel and just let it go,as far as temperature is concerned. In other words, I think just a temperature problem may be a relatively easy problem to handle in the Mississippi unless you are discharging into these pools which are a series of lakes. But if you get the thing in the main stream, we may have an easier job.

I suspect that the problem you pointed out is where we put the intake structure,and the restrictions on the antifoulants are going to be measures that are going to protect the water quality of the Mississippi River to a greater degree than shifting the temperature 1 or 2 or 3 degrees one way or the other.

Yes.

MR. BLOMGREN: My summary comment really is that if we establish a maximum temperature or a temperature standard we have to include something--

MR. STEIN: Yes.

MR. BLOMGREN: --concerning intake and discharge locations.

MR. STEIN: Right.

MR. BLOMGREN: O. K.

DR. MORRIS: What do you really mean by an antifoulant? Are you talking about the addition of chlorine?

MR. STEIN: That is right.

DR. MORRIS: And if you are, we can conceivably be putting a lot of preresidual chlorine into the river when we chlorinate the effluent from sewage plants and we are being ordered to do this by EPA. What do you mean by antifoulants?

MR. STEIN: Well, this is precisely what I mean, and I am not sure that the other practice is a good one. But what I mean by an antifoulant is putting something like chlorine into these pipes in a powerplant. That is precisely what I mean.

DR. MORRIS: You are going to make a lot of powerplants unhappy as far as operation goes if you tell us that we can't use on once-through systems some method of controlling biological slime formation in condensers.

MR. STEIN: Oh, I think there are--the point is again, maybe we want to get into this--I think there is a reasonable alternative. They can use mechanical means for this. As a matter of fact, the group that was here yesterday talked in terms of sponges and mechanical means. Now, I really think that recognizing this problem with powerplants, you are going to find more and more powerplants going to mechanical means of antifouling devices and this is going to become increasingly a smaller problem. It is not going to be that expensive and they are just going to cut it out. This is the easiest agreement we have had from the powerplants in stopping the use of chemicals as antifoulants which are going to affect the biota.

And I do agree with you, Mr. Morris, that we have to take a hard look at what we are recommending that we do as a finishing touch in our municipal waste treatment.

We are doing that, aren't we, Don?

DR. MOUNT: Yes.

MR. STEIN: Yes. I think this is certainly what we are doing.

I again put this with you. I do not think that you are going to get, since the question of antifoulants was raised, too much of a question from the power companies that they cannot substitute adequate mechanical means to handle this problem. The basic thing is, and this is a personal conviction and I am certainly not talking for the scientific staff, I think the most careful thing we have to do is place the powerplant or any other plant that is using a large quantity of water for process water in a location where we will take a minimum amount of the stream or lake or estuary, the water biota, and you have to take them from a place where there is going to be a minimum amount of this and run them through the plant, because with the large amounts of waters we are using if we just pull these things in through the plant and run them through and maul them and bruise them and run them through again and again and again, and if you are talking about a third of the Mississippi River going through powerplants and we are not careful not to knock off the dissolved phytoplankton and the fish fry, we may just be doing a lot of mechanical damage. Just the intelligent placement of these intakes can preclude this and this is not one of these tremendous plant expenditures.

You have just got to think in terms of the problem and put your intake where you are not sucking all this stuff in, and given your location I think this is a problem that can be worked out. I am very happy for the Illinois people who have brought this up because I think these two items are the essential items, really, on the control of the powerplant problem or these large water use problems. In a sense I think they are probably more vital than that heat problem, and this is just a personal view. We sure haven't got that across to the public.

All right, do you want to go on?

ZONE IV

MR. DICKSTEIN: The next zone is Zone IV, which is from Alton Lock and Dam to the Arkansas River. Now, this is a breaking point in the river where we lose our colder water species and start getting down into the warmwater species area.

This area includes Missouri, Illinois, Kentucky, Arkansas, and Mississippi. So quite a few States share this particular zone. Tennessee, excuse me.

This also reflects the predominant temperature of the Ohio River, which at that particular point is a major tributary to the Mississippi.

MR. STEIN: The Ohio will be coming in at 89?

MR. DICKSTEIN: Yes.

MR. STEIN: How about the Illinois, that comes in at 89 too?

MR. DICKSTEIN: I don't have the data on the Illinois

River per se. Do you have that?

MR. POWERS: I don't think so.

MR. DICKSTEIN: Does Illinois have any data, Mr. Kee, on temperatures or does the staff from the Chicago region?

MR. STEIN: I don't think that is a problem.

MR. BLOMGREN: Again with the proper definitions we have no argument with that.

MR. STEIN: Yes. The last thing I am worried about on the Illinois River is the temperature.

Is there any problem with this? This looks kind of liberal.

Go ahead.

ZONE V

MR. DICKSTEIN: Zone V, which is the last zone--

MR. STEIN: How far down is this?

MR. DICKSTEIN: This goes all the way down into the Gulf.

MR. STEIN: Way down?

MR. DICKSTEIN: To the tide waters of the Gulf. It goes from the Arkansas River to the tide waters of the Gulf.

MR. STEIN: Give me a place. [illegible] you stop above New Orleans?

Discussion on Zone V

MR. DICKSTEIN: It's an area they call the Head of Passes. It goes just below New Orleans. It fluctuates quite a bit.

MR. STEIN: After that we don't have any con--as far as this we are not going to control?

MR. STUBBLEFIELD: That is right. It will go with the coastal waters.

MR. STEIN: Doesn't the tongue ever go up above New Orleans or the tide waters?

MR. STUBBLEFIELD: New Orleans is almost 100 miles above that.

MR. STEIN: I know it.

MR. STUBBLEFIELD: And there have been cases that the salt water wedge goes up as far as Baton Rouge.

MR. STEIN: That is right.

MR. STUBBLEFIELD: But that is on the bottom 10 feet of maybe an 80-foot depth.

MR. STEIN: O. K. This may be a local problem, not with you. I know this problem. What I am trying to do is not fool with an essentially critical area, maybe not to these people, to Louisiana. No one is here from Louisiana. But between Baton Rouge and New Orleans we have a tremendous industrial buildup, as a lot of you people might know.

The issue that I want to know here is are we including that below New Orleans or are we going to have a squawk that this tongue goes up to Baton Rouge and these guys are excluded?

MR. STUBBLEFIELD: Of course I can't speak for Mr. Lafleur except for what he said in the past. His position in the past has been that the temperatures get as high as 92 and 93 at New Orleans and this zone goes below New Orleans that we are proposing.

MR. STEIN: Can't you give me a location rather than the tide water? How many miles below New Orleans? Where? Where does it go?

MR. STUBBLEFIELD: The trouble is it fluctuates as much as 80 miles, Mr. Stein.

MR. STEIN: Well, I know. And again I hope you fellows will bear with me, but in that 80 miles it fluctuates we have the Who's Who of American industry--

MR. STUBBLEFIELD: Yes, sir.

MR. STEIN: --sitting there. Now, are they in or are they out? And I think you have got to set the zone. When we start at Baton Rouge and go down to Gramercy and through New Orleans, we have got one tremendous $100 million plant after another, and that 80 miles means that either they are going to be in this or they are going to be out of it.

Now, if you mean below New Orleans and you mean this to stay below New Orleans, then give me a metes and bounds.

But I don't think we can deal with an 80-mile fluctuating boundary with tremendous plant after tremendous plant sitting back to back there when sometimes they are in and sometimes they are out.

MR. STUBBLEFIELD: If we want to be sure that we do not have this condition, I suggest we set the boundary just above Baton Rouge, because the area from Baton Rouge on down is sometimes in and sometimes out.

MR. STEIN: Well, if you set it just above Baton Rouge, you have done a great deal, you have eliminated every significant real big industrial source in Louisiana. Maybe you want to run for Governor. (Laughter.)

MR. STUBBLEFIELD: No.

MR. STEIN: This is where we--

MR. STUBBLEFIELD: I am not saying eliminate it.

MR. STEIN: This is where we have all the sources of pollution.

MR. STUBBLEFIELD: Sir, I am not suggesting we eliminate it. I am suggesting we set another zone there.

MR. STEIN: Why don't you--and again I know this may be a--again let me try to--

DR. MORRIS: Don't apologize. We are academically interested. (Laughter.)

MR. STEIN: Essentially what we have between Baton Rouge and New Orleans is a kind of industrial buildup which is comparable to something like the Houston Ship Canal or that Chicago Calumet Indiana area and I think it is vital for that portion of the river whether they are included or what their requirements are, because this is where all the big industries are.

MR. STUBBLEFIELD: Let me say once more, in my opinion, and I think perhaps Dr. Tarzwell might agree with this, let's say there is no industry there and we are only talking about the salt water wedge when Columbus came over, the salt water wedge is on the bottom part of the river and normally it will be cooler than the fresh water in the summertime when we are talking about these maximums, so I think we can disregard it as far as the maximum goes. If anything, the salt water temperature in the lower part of the river will bring the temperature of the river down somewhat, but it is going to slide out, the fresh water will slide out over the salt water for miles out into the Gulf, and this wedge gets shallower and shallower until it gets up around New Orleans. Sometimes it is 10 feet deep on the bottom, sometimes it is 20 feet deep.

MR. STEIN: Sometimes it is more.

MR. STUBBLEFIELD: That is true.

MR. STEIN: But what you are saying, and here is the problem we have, this is the question that Mr. Morris brings, what you are saying is, you know, for a period of 80 miles these guys are going to have to put in a capital investment and not be able to regulate that. Let's suppose a guy wanted to discharge into the salt water wedge when it came in.

MR. STUBBLEFIELD: Yes, that is right. It is not going to be there all the time.

I would suggest that we need a more precise definition than tide water, that you have got to give us, like you have done on the other places, to the Rum River, to the border of something. If you want to go to New Orleans or Algiers or something like that, we have got to. But I don't think you can deal with this tide water business when we have got that kind of fluctuation on there of over 80 miles and those 80 miles include the major discharges in the area. Sometimes they are in, sometimes they are out. Both we and they have to be entitled to a pretty precise definition.

I don't say that these people do not want to do what they are supposed to do, but we are going to have to tell them what they want to do, whether they are in or out, and not deal with an 80-mile fluctuation.

MR. STUBBLEFIELD: All right, sir, rather than take up everybody else's time, let me recommend that we use the tide water zoning point that Louisiana uses and then submit them--

MR. STEIN: What is that point?

MR. STUBBLEFIELD: Ten miles above the Head of the Pass, the mouth of the river, and then submit it to them for approval.

MR. STEIN: In other words, that will be 90 miles below New Orleans?

MR. STUBBLEFIELD: Approximately.

MR. STEIN: I am ready to go with that.

MR. STUBBLEFIELD: At Mile 10 on the river.

MR. STEIN: All right, Mile 10. If you can keep it down to 90 over there, that's great. But there is nothing down there, there is really nothing down there. There are really no artificial sources below New Orleans. So at the present time I think from a practical point it doesn't make any difference. I would hate to see a plant try to go in there.

MR. STUBBLEFIELD: Well, industry goes down as far as Venice at Mile 30, they have a big sulphur plant there.

MR. STEIN: Yes, but they are not putting this kind of stuff in.

MR. STUBBLEFIELD: No.

MR. STEIN: All right. O. K., let's try it with that. We will keep that open a little, because I would suspect that any plant down 20 or 30 or 40 miles below New Orleans that had a substantial heat load that they were putting out in the river might have a little trouble.

MR. STUBBLEFIELD: So that approved Louisiana standards and State-Federal standards have a dividing line for the tidal waters of Mile 10, so this should be--

MR. STEIN: Do they have 90 at that point?

MR. STUBBLEFIELD: No, sir.

MR. STEIN: I am not troubled with the Mile 10. I am troubled with--I am asking you about--well, I don't think we should take up the time, but we will have that listed.

Again to this group, what I want to indicate, I don't know, I am not sure about those figures, but it may or may not be possible to get down to 90.

MR. STUBBLEFIELD: Only a small percentage of the year will the temperature at New Orleans rise above 90.

MR. STEIN: All right.

By the way, as Mr. Stubblefield points out, as you go down below New Orleans you pick more and more of the salt water tongue up and the water tends to be lower in the stuff coming in from the ocean or the Gulf, so it is not as bad as it might seem.

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Could we set this last one down to Mile 10 and see what happens? Can we do that?

MR. DICKSTEIN: See what happens, see what kind of response we get from Mr. Lafleur.

MR. STEIN: All right.

MR. MARTIN: I have one more question, if we are about completed on the zone concept here. May I ask this question at this point?

MR. STEIN: Yes.

MR. MARTIN: Suppose in Tennessee a Judge will be asked to adopt similar standards for other--for waters other than the Mississippi River. If so, say we have a power unit on a lake and it pulls this water from the bottom portion of the lake and there is a temperature differential here of 10 degrees, do we measure the rise on the top surface of this lake or the bottom temperature?

MR. STEIN: I wish I had had you here last night. (Laughter.)

I don't know. Do any of you fellows want to try this?

MR. MARTIN: I move we adjourn. (Laughter.)

MR. STEIN: I don't know what we do. Now, let me tell you, we are going to--I don't have an easy answer to this. We are feeling our way.

I think from a technical point we may be taking the easy case, although politically it is a very hard one. We are going up to Lake Michigan in a week or two. Lake Michigan has this advantage. It is the only--if you look at the map--the only all-American Great Lake, so we have complete American jurisdiction over that. We don't have to share it with our

Canadian brothers, so we can set this.

Also Lake Michigan is so big that the economics of putting something out to a deep portion of the lake may dictate whether they are going to a closed system or they are going to try this.

Now, obviously when you get a smaller lake, as you have in Tennessee and you have an epilimnion and a hypolimnion, we are going to have to meet these problems, and I will stay on the record here because I will give you my view.

I do not think it would be too bad, again to my way of thinking, to take the water from the lower and cooler part of the lake and allow a certain measure of heating. The reason for this is precisely what the Illinois delegation was talking about. If you take the water from the lower portion of the lake and run it through, you are apt to get less plankton, less fish fry and less material that you are going to run through that you are going to wreck by going over the condensers. In other words, I think the chances are, just speaking broadly, unless you have special conditions, that you are going to do less ecological damage by just drawing the water in where there is less of the life, less of the food chain that you want to protect in the lake.

If we adopt the thesis that this may be the major part of the problem, the advantage of encouraging someone to go from a portion of the lake which has the least desirable biological contact to use water for their intake water may be something we want to encourage, and this is the way I tend to think now.

I am not speaking officially for the agency. I haven't discussed this completely, certainly, with the scientific staff. I have a feeling that they tend to agree with me on this and they are obviously more cautious than lawyers and don't want to speak yet. But these are the feelings I have now.

If you are going to do this for other reasons, I think that this will have the added factor of giving us a little more flexibility in adding heat.

Again let me go over this problem. As I see it, and I think I would agree with Dr. Morris, what we have to do is protect the water source or protect the stream. That is where we are in business. I think heat is just one portion.

Here is what we have in this whole problem. You have to protect the hydrology of the waters where you are dealing with your intake waters. Now, presumably you can't pull waters in in such an amount and such a velocity that it is going to cause a rush of other waters to take its place that is going to change the ecology of the intake waters.

The second point is what you are going to do aside from heat when you run your minute organisms through your condensers. The mechanical damage, which may be one part. The second part may be after you have mauled them and bruised them, you give them a shot of chlorine, and then if you haven't knocked them off yet you heat them up a little and you hold them at that top heat and then you put them out and let them die. All these combinations, and I am not talking about what happens to the receiving waters with the heat going in or what this combination of the mechanical mishandling and a shot of a chemical and a shot of heat will do to the organisms you pull in. If you are depleting these enough and you are sucking in enough water, you may deplete and you may change the ecology of the receiving and the discharge waters.

The third point, of course, is what we have been discussing here now, is what the heat, just the addition of the heat, will do to receiving waters. As I say, this is just maybe one-fourth of the problem.

And fourth is what we do to the hypo. By the way, if you are going to kill these organisms off, you are going to drop trillions and trillions of little carcasses out that are not living out their life cycle and are going to disintegrate when they get out into the receiving waters and you are going to further change the ecology.

And the last point is what you are going to do after the--the third point is heat, but the last point is what you are going to do just by the volume of water coming out, whether that is going to keep normal water from flowing in, push it back, and that is going to change the ecology. I think we have to, considering the size of the lake, consider all these factors.

The advantage, possibly,of moving in on Lake Michigan for political reasons, which I admit are tough, is that the likelihood that we are going to suck too much water out or put too much water in is remote. We are off those problems. If we put the intake places in the right place or you have a closed cycle, you may not be going to be able to affect the minute organisms and then we can zero in on the effect of the heat discharge.

When you look at this,it becomes evident that the one system which can meet all these objections is a closed cycle and that is the only one that automatically meets this. If you don't have a closed cycle, you are going to have to be very careful about levels and places you take your water in, what material you have to have when it comes in, whether you are going to use mechanical or other chemical means as an antifoulant, what you are going to do about the heat you put out and the velocity that you put it out and the amount you put out and where you do it.

I think when you raise this, this is the scope of the problem. Now, get to your specific. If you get a relatively small lake, if a man wants an essentially closed system he has this lake, more or less. If he doesn't want to go to a closed cycle, I think he has to come up with a plan where he is going to meet all these conditions. In other words, he is going to have to find a part of the lake where he is going to have to get his water in where it isn't too biologically active in the first place and he is sucking out all the desirable biota into his plant.

Secondly, whatever he takes in he is going to have to be sure he is not using a chemical antifoulant. He is probably going to be restricted to a mechanical antifoulant.

Thirdly, I think he is going to be restricted to some very severe temperature rises, and generally speaking we are talking about 5 degrees here, but these fellows in the national group have recommended only a 3-degree rise on lakes, not 5 degrees.

Fourth, you are going to have to deal with the maxima for the lake fish, whichever is less, but you are going to have less of a push on that.

And fifth, unless you have a very big lake, you are going to be under very, very severe resitrictions as to what is an adequate mixing zone, because you can't take up the whole lake, depending on the size of the lake.

In other words, in a small lake you are going to be practically limited to zero, almost zero. In a relatively large lake you may be able to go up to a maximum, and I am just giving you ball park figures, of 5 to 10 percent of the lake. And this doesn't give you much leeway.

Now, the other thing that has happened is that some of the powerplants, particularly in the Midwest, have built artificial lakes just for their powerplant, and I am not sure that this isn't the effect of what we are doing on the Great Lakes. In other words, they are faced with two things, either a closed system using cooling towers or getting away from an actual watercourse like the Great Lakes, say, building their own private lake, using that lake as, in a sense, a lagoon and that lake is part of the closed system of the powerplant.

I suspect that more and more we are going to find that last thing is the solution to what you have. In other words, you are going to find a powerplant which needs water going out and picking a site and building its own lake and buying the land around that lake and, instead of using possibly a tower, using that or a lagoon or a pond or whatever you have and running that water back and forth and back and forth and that is going to be their source of supply.

DR. MOUNT: Murray, could I comment on this business?

MR. STEIN: Yes.

DR. MOUNT: I don't disagree with what you said, but

I think that in the case of these smaller lakes where they are stratified and where the amount pumped through the plant is a significant amount in terms of the size of the lake that there are two clearcut cases where one can say something about the advisability of pumping out of the bottom. I think it is pretty clear that in those lakes that the fisheries people call two-storied lakes where you have salmonid in the bottom, I think it is pretty clear that we don't want to pump water out of the hypolimnion and put it in the epilimnion for obvious reasons. On the other hand, at the opposite extreme where you have a stratified lake and there is no oxygen in the bottom water, I can't conceive of how you are going to do anything but improve that lake by taking the water out of the bottom and putting it into the top, aerating it in the process. Those are the two extremes and, of course, in between there are a whole flock of lakes where it isn't so clear.

But as I say, I think in these salmonid two-story lakes, like the one we heard so much about in New York, for example, there are some pretty good guidelines about what we ought to do.

MR. STEIN: In a salmonid lake you are not going to have any heat, are you?

DR. MOUNT: That's--

MR. MARTIN: Of course you get over to another phase now.

MR. STEIN: Yes. By the way, I don't know if they have this in Tennessee. You know, maybe I was relating the question to you. But the guidelines are that when you have a salmonid lake, that is trout, coho salmon maybe, no heat at all. Now, presumably I think we have come to the conclusion--I may be wrong on this. If I am wrong, not only do I want to correct it but I want it stricken. But I don't think we meant this to apply to something like the Great Lakes. In other words, they are relatively small salmonid lakes. You might say that the Great Lakes are salmonid because they have coho salmon or lake trout.

Yes.

DR. TARZWELL: When we sent out the suggestions in the water quality in what is called now the Green Book, we suggested that there should not be any water taken from the hypolimnion or any heat added in those lakes that had a population of salmonids, that is white fish, lake trout, trouts, three species, or in some cases actually salmon. Now, these were the smaller inland lakes.

I think that the committee did not mean such lakes as the Great Lakes where you could take water out of the hypolimnion where there are salmonids but you would not overturn it. See, the smaller ones you could take so much you would overturn it and use up the hypolimnion and make it all one temperature, which would wipe out the salmonids fishes, which were the most important. In the Great Lakes you can take out a great deal of water and you will only lower the thermocline, and unless you take a tremendous amount in a lake like Lake Michigan you are not going to lower the thermocline a significant amount.

Do you follow me on that?

MR. MARTIN: Yes.

MR. STEIN: O. K.

You know, the trouble is, you ask a question and you are answered by experts who want to give you the whole explanation.

Do you have another one, Mr. Martin?

MR. MARTIN: One point that was raised by Dr. Mount here. When you pull this water from the lower stretches of your lake we are talking about waters that have zero DO, in many cases, and of course in my concept you are not adding too much DO to the water when you run it through your condensers. I stand corrected on this, but I don't see how we would add too much. Then you are putting the water back out on the surface that has a relatively low dissolved oxygen,comparatively speaking here. We are getting into another facet of the pollution control now.

DR. MOUNT: I don't think so--

MR. MARTIN: You don't think so?

DR. MOUNT: --because there has been quite a bit of work done on destratifying lakes using compressed air in particular as well as pumping with water pumps of various sorts, and I worked fairly closely with Bill Erwin on this problem in some of the Kentucky lakes back a few years ago and I know that one of [illegible] questions that arose, at the time it was kind of an academic question, about whether the oxygen they were putting into the water was coming out of the bubbles of air that they were putting in at the bottom or where was it coming from. They analyzed some of these bubbles and they found out that it wasn't diffusion from the bubbles to the water that put the oxygen in but it was this surface exposure when they got it to the surface, and this is consistent with what some of us have seen in other situations too.

So I think the key here is that the discharge ought to be located right so that it does get onto the surface and can pick up oxygen. This would be my theory.

MR. STEIN: When were these tests done?

DR. MOUNT: Oh, 1963, 1964, 1965, in there.

MR. STEIN: That figures. You know, I have been interested in biology, as a matter of fact that was my science in college, but I have worked with this for many years and I remember years ago--the biologists can check me on this--when they did experiments with just these little fish tanks where you have the exotic and tropical fish where they bubble it up trying to find out where the oxygen or what the bubbles do to produce oxygen in the water, and they came to the conclusion that just the oxygen put in the bottom and coming up wasn't doing much good but the breaking of the surface would oxygenate the water and that was a great thing.

I think this is the same kind of thing. As I understand what Don is saying--and again let me put it here and Don can correct me--if you are taking water from a relatively non-oxygen strata or very low oxygen strata and you bring this up to the surface, even though you heat it, and then you discharge it, it aerates and it breaks the surface and you are going to get more oxygen totally in that lake than you had before, is that more or less correct?

DR. MOUNT: I think so. I don't have any current data on it.

MR. STEIN: Yes.

DR. TARZWELL: In records of powerplants where they put it through the plant, the simple putting it through the plant, through the system, through their vacuum breaker, through the great turbulence, results in aeration as well as if they heated and then discharged it near the surface so it spreads over the surface, then you do get further aeration. But you get both of these things operating.

MR. STEIN: Yates.

MR. BARBER: A paralleling thing or force that goes along with this is when you bring up that water out of the bottom that has no oxygen, frequently one reason for the lack of oxygen is biological activity and if your upper layers were deficient in nutrients, then you might be fertilizing your lake. If your upper surfaces are already pretty well nutrient supplied during your hot season, then you may, of course, be accelerating the so-called eutrophication process a little bit by overfertilization. I think it is an individual case, but it is a parallel activity that you may be engaging in.

MR. STEIN: Do you people have any more questions? Let me just make one remark.

I think we have the biological staff here and if you are going to ask any questions, I think this is a good time to do so.

Go ahead, Mr. Kee.

MR. KEE: My question before we get off this zones business, I think it is probably for Mr. Dickstein, Illinois has not yet had its Ohio River temperature standards approved and in January when we were here the booklet that was passed out had Ohio River standards monthly recommended--

MR. DICKSTEIN: Those are the approved standards for the Ohio River.

MR. KEE: Those are approved standards for the Ohio River?

MR. DICKSTEIN: Yes. Those are compatible with Indiana, Kentucky, Ohio.

MR. KEE: What I wanted to ask, there has been no change in these?

MR. DICKSTEIN: No.

MR. KEE: And if we could consider these as--

MR. DICKSTEIN: I hope you adopt them. It will save us a lot of problems.

MR. KEE: This is the reason I raised the question.

MR. DICKSTEIN: Very good.

MR. KEE: Do you have similar recommended--

MR. DICKSTEIN: Why don't we send you the exact adoption that Kentucky and Indiana had so there will be no question in your mind, how is that?

MR. KEE: These, I note, are identical to what you recommend for Sector 4, which is the lower part of the Mississippi and Illinois.

MR. DICKSTEIN: Yes.

MR. KEE: What about the Wabash River?

MR. DICKSTEIN: We can send you those also.

MR. KEE: I would appreciate that very much.

MR. DICKSTEIN: What the Indiana has on the Wabash.

MR. KEE: All these things are monthly highes, maximums?

MR. DICKSTEIN: Yes, it is a monthly table.

MR. MARTIN: One other comment. Tennessee's temperature standards have not been adopted, as Mr. Stein probably knows, but the only thing I can do is to go back to my Board and take the data which has been presented to me today to them.

MR. STEIN: That is right, I think several of the States we haven't adopted the temperature standards. Some have to be revised.

This may or may not relate to this, maybe some of this puzzles you, but as you know I am handling the standards provisions now and one of these principles we have is either we are going to approve the package or we are not going to approve it. We are not going to approve it piecemeal. The difficulty that I faced was when I came into this program or it was transferred to me,I found out that all of the States had some things approved but most of them didn't have the whole thing approved and they were in a real problem. And I thought that was a pernicious state of affairs, because what you would be doing is you would have a tremendous amount of time invested in negotiation and then they approve one extra little portion and they cross a T or they dot an I and all this work would go on and the letters would go back and forth, and as far as the operation of the program I didn't see anyone was one bit ahead by having just a little section approved.

So what we have tried to do is either we are going to approve a whole package or we are not going to get it approved, and by that method I think we have really accelerated the approvals of the States. We have got a tremendous number of the States approved now by working as a package, and again this may be by professional predilection, because I find when I go in if there is any argument or any basis of negotiation, if I come in with a whole package on 10 or 20 or 30 items sometimes that there can be a little give or take and we can approve the whole package and I think we are in better shape. And I think this is the way it has panned out.

So you won't be getting these niggling little approvals of something that really doesn't approve your standards. Either you are going to get the package approved or you are not going to get it approved.

MR. SMITH: Mr. Stein, do you have a date in mind when you would anticipate the States approve these standards?

MR. STEIN: If we get these out and we have an agreement, I would hope you would approve these standards as rapidly as possible and if we do we can put these through.

Now, I would suggest that the States might think of this themselves. I know you all have your problems on approving this and some of you have had complete standards approved. What I would suggest, we are going to have a new regulation come out, since you raised this. Why don't you bear with me on this. And I think we had to do this.

If you have your standards all approved, then the only thing you can do is change them. And as I read the statute, maybe you like it or not but I think we all read the statute the same way, the only way to get your standards changed now is one of two ways, either we can do it, we prefer not to do it that way, or you can ask for it. But the way you have to ask for it is once you have had it approved is to get a change, and to get this change you have to ask your governor to ask us to change it.

Then we have to call a standard setting conference the way we did in Iowa, and this is the only way we can do this under the statute. I know you shake your head, but this is coming out. You are going to have a standard setting conference and hopefully if we are in agreement this is going to be a pro forma agreement on the standards and will give the people an opportunity to have this heard. If the Federal and State people agree, we can do this for a--we will have to do this even for changes in dates.

Here is what the law says and this is the only thing the law says, and I suggest you people may want to listen to this because this is what we are bound by.

MR. SCHLIEKELMAN: What is that section?

MR. STEIN: It is on page 22 and it is very tricky. It is 10(C)(2) on page 22.

MR. MARTIN: What is the document, may I ask?

MR. STEIN: It is the Federal Water Pollution Control Act. Here is what the essential language says:

"....if the Secretary"--and read that "Administrator"; leave that out--"or the Governor of any State affected by water quality standards (established) pursuant to this subsection desires a revision in such standards, the Secretary may, after reasonable notice and a conference of representatives of appropriate Federal departments and agencies, interstate agencies, States, municipalities and industries involved, prepare regulations setting forth standards of water quality to be applicable to the interstate waters or portions thereof."

Now, if after six months from the date we publish such regulations the State has not adopted water quality standards or a petition for public hearing has not been filed, the Secretary shall promulgate such standards.

Now, I don't know that the Congress had this in mind when they passed the Act, but this is the only language in here for revision of the standards. In other words, if you are going to revise the standards, you have to have your Governor request it, then we will publish a notice in the Federal Register, set up one of these conferences, and I think where there is no controversy it should be relatively low level or low profile, and hold the hearing, then publish it in the Register and if the State adopts it, that is it.

Yes. Are there any comments?

MR. KEE: What you are saying is that Illinois, for instance, cannot move to tighten water quality standards to improve already approved water quality standards without having a Federal conference?

MR. STEIN: No, I am not saying that at all.

MR. KEE: It sounds like that is what you are saying.

MR. STEIN: No, I am saying-- By the way, we are not talking in terms of tightening.

MR.KEE: I am.

MR. STEIN: Here. Most of these changes we have coming up are for loosening and for extending the dates.

MR. KEE: Not in Illinois, sir, that is not--

MR. STEIN: The point is a State and maybe--I am glad you asked the question. The issue is if they are to be Federal standards, you have to go through this procedure. As far as I am concerned, the State can have much more restrictive standards than we have. We don't operate like--you know, I am not arguing this, but Minnesota representatives here at the AEC contended they couldn't have a more strict requirement in Minnesota than AEC had and AEC prevailed. I don't think we have exclusive jurisdiction. We have concurrent jurisdiction with the State. If the State wants to adopt more restrictive standards or more restrictive requirements on anything, bless them, as long as that agrees with the Federal standards. However, if you want these to become Federal standards, you have to put this in.

But I think, Mr. Kee, you may be running into a special case in Illinois. The usual case we run into here where these come up is the State has said that, say, X city will have secondary treatment by June 1971 and that is part of the implementation plan and it is part of the standard and then it becomes obvious to the State or maybe the city for what both the city and the State consider good and valid reasons that they can't possibly make this date. Now, if they are going to get our approval, they have to go through some kind of mechanism to loosen them up and adjust them.

MR. KEE: What we are talking about here, of course, are temperature standards and many of the States already have 90 degrees adopted or approved as their water quality standard and I think you are proposing here tightening that 90 degrees to these numbers that you have given, so that would be an example of them going tighter and that is what I meant. That is what I was speaking of.

MR. STEIN: I think if we are going to tighten all the way down the line I would recommend strongly that the States request us to do this, because if they don't we are going to do this on our own initiative. I would much rather, and I think the States would too, I would much rather we responded to a State request than we issued one of these ourselves if this is what we are agreed on on this. But on other proposals that you propose to tighten, there is no restriction to a State or a city or a county having tighter requirements than us.

I assume in Illinois you are the same way, you don't care if a city or a county has tighter requirements than the State does, do you?

MR. SCHLEUGER: That is correct.

MR. KEE: That is right.

MR. STEIN: Right. And we feel the same way. But I think with this temperature, particularly on the Mississippi, in order to make this legally enforceable, if we don't get a request from the State, as Jack Smith points out, pretty soon we are going to have to take action ourselves in accordance with that.

MR. KEE: It is interesting, because the States that are approved already, which Illinois is not one, they will have to go through this Federal conference even albeit a low level one--

MR. STEIN: Yes.

MR. KEE: --to get a change, whereas Illinois, since we do not have them approved yet, we do not have to go through a Federal conference.

MR. STEIN: That is right. I do not say that this is a desirable way of doing this, but as I read the law there is just one sentence on how we do it.

Now, I think this can be done very fast. In other words, after the conference, after we have that meeting, even though it is a low profile meeting, and the way we do it we are going to have either a regional or a basin or some guide maybe from this and see what it is, and if we are all in agreement and the State publishes this themselves, why, that is just the change.

MR. KEE: Do you think it would be possible, not in Illinois case, but in the future would it be possible to integrate State hearings with this Federal conference or do you think they would have to be kept completely separate as to procedural matter? We have an awful lot of hearings in Illinois.

MR. STEIN: Let me put this to you. Theoretically I think that is completely possible. From a practical point of view, I don't know that I would advise that. In other words, let me put it to you this way.

We have a lot of hangups, as you people well know, in getting a regulation through either on a Federal or a State level. They don't have uniform procedures. To make them dovetail, while it is theoretically possible and you may want to do it, I am not sure it is not going to be more trouble than it is worth.

MR. KEE: As I think about it, you are right.

MR. STEIN: We may be losing time. But certainly there is no reason why it shouldn't be done.

MR. KEE: Yes.

MR. STEIN: Did you fellows from Iowa have some comments?

MR. SMITH: Well, these figures you presented here, if we presented these would these be approved?

MR. STEIN: Yes. Can I say that?

You know, I don't want to put myself in a position here. Let me give you this notion. Let me check with Yates on this.

The way I see, I can only make a recommendation to, well, the other guys; it goes to a commissioner, a general counsel and the Administrator. Now, generally speaking, when I have made a recommendation and I have the backing of the people you see here, and that is Dr. Mount and Rainwater and Tarzwell and particularly the Fish & Wildlife Service, they have always accepted it.

I would say yes, Yates, if they put in these figures, are you going to--

MR. BARBER: Yes, these figures hooked to the 5 degrees and these three conditions.

MR. STEIN: In other words, I think I can reasonably say yes. And again when you ask the question, I am going to tell you as far as Fish & Wildlife are concerned, if the Fish & Wildlife Service puts in an objection, as far as I can see, they have an effective veto. And my boss, what he is going to do is come back to me and say, "Can't you get together with the Fish & Wildlife Service and work this out?" In other words, he is not going to put this in. That is why I am asking.

So I think we can reasonably say in this situation yes, is that correct?

O. K. Because While we have to send this through a lot of policy people, all the technical people here who say yes or no are right here and we are all saying yes, and that includes me because I have to sign it. I am the guy whose name is on this thing.

Go ahead.

MR. WICKS: Would you suggest, Mr. Stein, that they just adopt these temperature standards for the Mississippi? What if there are other changes they might want to make or we might recommend?

MR. STEIN: Like what?

MR. WICKS: Temperature for the Missouri River.

MR. STEIN: Let me tell you. You know, this temperature business is so hard, let's do one at a time.

MR. WICKS: Thank you.

MR. STEIN: Let me tell you, we have done the Ohio, we have done the Mississippi, I hope we are going to be able to do Lake Michigan. My guess is, and this is like this, my guess is that once we have done a big lake like Michigan and once we have done the Ohio and the Mississippi, we will have set a pattern and the rest of the country will fall into place. And I am speaking right here on the record for everyone.

My guess is to try to set this up in as uncomplicated a way as possible on one river, get everyone to sign off on this, and we will see what it looks like. Once we have the pattern, I think the others will be kind of pro forma, but I wouldn't try to throw another river in on this. Keep them separate. This is complicated enough.

Yes.

MR. STUBBLEFIELD: May I assume that there will be some written proceedings come out of this so we can contact the States that aren't here?

MR. STEIN: What you are going to do is you are going to have a transcript coming out. Now, as far as the proceedings, we may put up the recommendations, and I think the recommendations, as far as I see this, are a 5-degree rise, what you would consider, which we did not define here, and maybe we will let this to each State, a 5-degree rise after an adequate mixing zone, plus the maxima put for each zone, and you have got it.

One of the problems, I suspect, because we didn't get into this yet, that you may have with our regions is to work out in terms of the adequate mixing zone what you think in terms of a mixing zone is. As far as I can see, Illinois and Iowa are pretty close, aren't you, with that 600 feet? I don't want to necessarily get into this, but this very well may--I don't think it should be a problem.

Do you want to discuss this on what you think a reasonable mixing zone would be?

MR. SCHLIEKELMAN: I would maybe kind of like to see what transpires at this meeting down at--where is it, Alton, the first part of April?

MR. KEE: It is the last part of April.

MR. STEIN: Yes.

MR. SCHLIEKELMAN: Maybe both Iowa and Illinois might be interested in that particular meeting down there, since I believe you people are going to be involved in that too.

MR. STEIN: Right, I am sure we will if we are asked.

But again, as you fellows probably know, and let me just speak for myself, I have an open mind on this. I believe, as you have seen in this meeting, that the States are going to contribute as much to this as we have. We are all trying to work our way toward a reasonable solution and any formulation or any solution you have that we can adopt and utilize for this problem I think we will all be grateful for. We just have to feel our way and work toward that. But I suspect that that is the thing you are going to have to work on.

Yes.

DR. MORRIS: I think the concept of the mixing zone can get so complicated and we have only discussed portions of it here, I would hope that we could defer the type definition of what we mean by a mixing zone into the future. I would hate to see a 600 feet set to it because it is something that can vary so much in the judgment of the individual circumstances. I would hope you would leave it verbally stated as a reasonable mixing zone.

MR. STEIN: That is the way we have left it right now. What I am saying is that I hope you all recognize what we have done, because while we have talked in terms of the 5-degree rise and the maxima for each month, when we have given you a reasonable mixing zone, when you get back home what you and your Board and our regional offices might think are reasonable under an existing set of circumstances may not be the same. In other words, we have not outlined that with the precision that we have taken care of the other factors and for the reasons you indicate, Mr. Morris. This is going to have to be a process of negotiation with you and our regions coming in.

When you ask is this acceptable, let me put it this way. Anything that is reasonable on this mixing zone we are going to take. Let me give you the procedure that I am going to have when it comes in with one of these, at least for the first few. First I am going to hope that you have a regional concurrence when you come in, and if you don't we will probably do the same thing, but I would hope that you and our regions, the appropriate regions, can get together in agreement on something.

Then when it comes in, I am going to seek the advice of this committee here, and you know the personnel again, the four members are sitting here, Mount, Rainwater, Tarzwell and Barber, and they are going to have to give me an affirmative recommendation that this is reasonable and then I will send it forward.

Now, if we don't get this, we are going to have to sit down and talk to the State. And what I would hope would not come, I would hate to bring this committee into play to adjudicate a matter between you and our region, the State and the region. I hope the State and the region can work this out in every case. I am optimistic on that because we have generally had pretty good agreement between the States and our regions on the proposals.

But in addition to that, when these mixing zones come in we are going to circulate that to the committee and ask if they will sign off on it or not, and if not they will have to give us their comment and if we get any dissents we will come up and talk to you.

Actually, if we operate with good will, as I am sure you are all going to do, and we use our heads, I don't think we are going to run into any difficult problems. The mixing zone problem, I think, just looks more formidable in the abstract or dealing with the philosophic concepts of it than it does when you are dealing with any particular outfall. There it kind of falls into place if you try to be sensible about this.

Are there any other comments?

I want to thank you all for coming. By the way, I think we have a pretty remarkable achievement here. Possibly this is the second one. We have done this on the Ohio, but I will say this for the Ohio, we just had two breaks, the upper Ohio and the lower Ohio. This is an infinitely more complex situation. I know probably you are thinking in terms of your own programs, but if we and the States can get this signed off on and put into effect, I think as a result of these meetings we have probably set the pattern and essentially solved the temperature standards problem for the internal rivers of the United States. This is no mean achievement. I really think this is just great because from here on in it is going to be variations on the same theme.

Yes.

DR. MORRIS: Speaking from the other side of the table, if there really is one, from my own standpoint, and I think from some of the comments that I have heard people make, we feel better informed now after having heard the testimony of your technical support staff and these temperatures that you presented today are somewhat different and I think far more realistic than the ones that we got a month ago. I am deadly serious. I think in a controversial area like this, this is the best way that we can come about it and in my judgment it is far better than it has ever been done before. I think a lot of us appreciate the people you have collected to bring in here today.

MR. STEIN: That is right.

Let me go off the record on this.

(Off the record.)

MR. STEIN: May we go back on the record?

I think this has been truly what I would consider and

I have always considered a State-Federal partnership program. I think what we have come out with here is an amalgam of the views of the State representatives and the Federal people. In other words, I am sure I didn't and I don't think any of the other people came in here with preconceived notions or preconceived positions, and I have learned a lot from the State attitudes and State positions in this operation. That is why, as I said before, I am very grateful for you people coming here and working this out with us because I know while you had to do this for the State program, this certainly sets a national pattern and I know no other way of doing this but sitting down with the States and getting your views and getting your attitudes and trying to put this into account and bringing the scientific staff that we rely on here for you to deal with directly. I really appreciate all of you taking the time, but with this we probably have saved more time and money for the State and Federal Governments in getting this thing resolved than we could have done any other way.

DR. MOUNT: Murray.

MR. STEIN: Yes.

DR. MOUNT: It could just be that when you get the biologists together you get something done. (Laughter.)

MR. DICKSTEIN: Take that off the record. (Laughter.)

MR. STEIN: You know, Don, it could just be that by getting the biologists together I get something done. It is the hardest thing I have ever done, to get them under one roof. (Laughter.)

Are there any other comments or questions?

If not, thank you again for coming and let's adjourn.

(ADJOURNMENT)

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REPORTER'S CERTIFICATE

I, Virginia H. Rankin, Certified Shorthand Reporter, hereby certify that the proceedings had in the matter set forth in the caption page hereof were reported in shorthand by me, afterwards transcribed, and that the foregoing pages numbered 1 to 289, inclusive, contain a true transcript of said shorthand notes.

Virginia H. Rankin, CSR
Certified Shorthand Reporter